INTEGRATED EDITION OF THE PETROLEUM ENGINEER

the Petroleum Engineer

FOR MANAGEMENT

SEPTEMBER 1959

CONTENTS: 2 AD INDEX: 6

ONE DOLLAR FIFTY CENTS A COPY

Weigh Your Paperwork

. . . System eliminates surplus office paper routine ..... *Page E-1*

Do On-The-Job Training

. . . Chapter in "How to be a Manager" series advises self-measurement ..... *Page E-5*

OMVAG Struggles With Reds

. . . Austrian oil director reveals Communist methods with workers ..... *Page E-8*

Companies Make Sharp Come-Back

. . . Oil concerns show 26% increase for first half over 1958 ..... *Page E-12*

Engineers and Scientists Oppose Unionism

. . . Survey brings out why one in five approves collective bargaining ..... *Page E-16*

"New Economics" Is Throwback

. . . Keynesian theories said to bring inflation and unemployment ..... *Page E-22*

How to Assess Nonuniform Reservoirs

. . . Various factors to consider . . . and how they effect recovery ..... *Page B-19*

Gas Density Data Speeds Reserves Calculations

. . . Number of steps involved reduced; accuracy of results upheld ..... *Page B-49*

Programming Distillation Calculations

. . . This method is available and amendable to a wide range of work ..... *Page C-35*

Calculating Tank Heat Losses

. . . Actual field tests and theory combine to provide realistic values ..... *Page C-21*

Pipeliners Fight Swamps, Rivers, Mountains

. . . Construction story of Pemex' long and difficult gas line ..... *Page D-19*

Graphic Engineering Digests

. . . Monitoring a super-inch for rupture . . . selecting TV equipment ..... *Page D-35*

THESE SAMPLES ARE ON THEIR WAY to the Dowell Laboratory. They're from a problem well that could be yours. The Dowell engineer will request a quick and complete analysis. The Customer Service Section of the laboratory will go right to work to furnish a written report of the facts. Combining the lab findings with his knowledge of local conditions and your specific well problem, your Dowell engineer can recommend the best treatment. Not every well problem requires a Lab report, of course. But when you *need it*, Dowell *has it*. These research facilities, this desire to dig deep, are more reasons why Dowell gives you the most value per treatment dollar. Dowell, Tulsa 1, Oklahoma.

Services for the oil industry

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

Austin F. Allen, Chairman of the Board Ben H. Mitchell, President Home Office: Dallas

The mortar which cements
any employer-employee
relationship is trust.
There is no more effective way of
increasing this trust than by providing
yourself and your employees with
the best possible workmen's
compensation insurance program, the kind of insurance
program which not only protects you but which offers
them fast, fair, efficient settling of every claim, safety
engineering to cut down on the possibility of accidents,
rehabilitation service in case of serious accident.
So always build with the best; see your TEIA man.

TEIA

First with Texas industry for 45 years

TEXAS EMPLOYERS' INSURANCE ASSOCIATION

President and Publisher
Abbott Sparks
Vice President and Advertising Director
E. V. Perkins
Vice President and Western Manager
J. E. Kastrop
Editorial Director
L. H. Johnston
Secretary-Treasurer

•

Ernestine Adams
Management Editor
Jack W. Williamson
Editor, Drilling and Producing
Frank H. Love
Editor, Pipeline Engineer
J. C. Webb Jr.
Editor, Refining Engineer
Lowell A. Murphy
Assistant Editor, Drilling and Producing
Walter A. Hogan
Field Editor
Jan Craig
Editorial Production Manager
Lynn Patton
Editorial Assistant
Cecile Pincus
Editorial Assistant
Donald D. Fickert
Presentation Editor

•

NEW YORK — **John L. McDonald**, **Clyde Dillehay**
52 Vanderbilt Ave., MUrray Hill 6-7232
CHICAGO — **E. V. Perkins**, **Robert T. Mahoney**
53 West Jackson Blvd., HArrison 7-6883
LOS ANGELES — **Richard P. McKay**
465 East Union, Pasadena, MUrray 1-0685
PITTSBURGH — **Art G. Gilliam**
121 Ambleside Dr., WEllington 1-0619
HOUSTON — **Jess Adkins**
2370 Rice Blvd., Room 110, JAckson 6-2631
DALLAS — **Ed Sealey**
800 Davis Building, Riverside 8-4403
BIRMINGHAM — **Fred W. Smith**
1201 Forest View Lane, Vesthaven
TRemont 1-5762

•

Allen K. Tyler
Production Manager
Glen D. Hebert
Assistant Production Manager
Paul J. Mansfield
Advertiser Services Manager
Charles McKean
Circulation Director
Royal Courtney
Circulation Fulfillment Manager
Sherwood R. Entwistle
Circulation Promotion Manager
Harold L. Seamans
Circulation Field Service Manager

Cable Address: PEPUB

Copyright 1959
The Petroleum Engineer Publishing Company
Indexed by
Applied Science and Technology Index,
The Engineering Index, Inc.,
and Chemical Abstracts
Member of Audit Bureau of Circulation
and Associated Business Publications

The Petroleum Engineer for Management, published monthly, August through June, semi-monthly in July, by The Petroleum Engineer Publishing Company, 800 Davis Building, Dallas 2, Texas. Subscription rate to the petroleum industry, United States, Canada, and foreign, $8.00 per year; $14.00 for 2 years; $18.00 for 3 years; $1.50 for single copy. Entered as second-class mail matter May 1, 1932, at the post office in Dallas, Texas, under the act of March 3, 1879. Please send subscription correspondence and change of address to The Petroleum Engineer Publishing Company, P. O. Box 1589, Dallas 21, Texas. Subscribers should notify publisher promptly of any change of address, giving old as well as new address, and including city postal delivery zone, if any. If possible, enclose an address label from a recent issue of the magazine. Allow one month to six weeks for change to become effective.

THE PETROLEUM Engineer

FOR MANAGEMENT

NUMBER 10 • VOLUME XXXI • SEPTEMBER, 1959

The Conference Table **A-10**

"The United States has never lost a war nor won a conference." — Will Rogers.

Your Eyes — They're Wonderful **A-16e**

Here are a number of eye-care habits you should cultivate to protect your sight.

Why Not Guarantee Your Investment? **A-16g**

A United States Government guarantee is available for new investment in friendly foreign countries for a small charge.

E SECTION FOLLOWS A

Weigh Your Paperwork **E-1**

Sometimes you can see results of simpler paperwork in dollars . . . Other times you can only see a quicker, smoother job that gives the worker cause for pride.

— *F. X. Wernett and L. E. Salisbury*

Do On-The-Job Training **E-5**

One in a series on "How to be a Manager" . . . a guide to a better job.

— *Lincoln Atkiss*

Austrian OMVAG Struggles With Reds **E-8**

An interview with Dr. Margarethe Ottillinger, vice president, Osterreichischen Mineralolverwaltung A. G.

— *Ernestine Adams*

Companies Make Sharp Come-Back **E-12**

Oil concerns show 26 percent increase in earnings for first half over 1958.

— *Ernestine Adams*

Engineers and Scientists Oppose Unionism **E-16**

Survey reveals a strong minority of one in five favors collective bargaining either through unions or professional societies.

"New Economics" Is Throwback **E-22**

Henry Hazlitt takes Keynesian theories apart and finds they produce inflation and unemployment — but they are still being used.

DRILLING AND PRODUCING

The Atlantic Lectures of The University of Texas
Part 11: Reservoir Inhomogeneity Assessment and Control B-19
C. A. Hutchinson, Jr.
Volume Variations of Underground Storage Reservoirs B-27
H. D. Yoo, D. L. Katz, R. R. White and M. R. Tek
Addition of LPG and Gas to an Oil B-32
J. G. Roof and N. W. Crawford, Jr.
Velocity Logging: A New Family B-35
Howard Itten
Calculating a Water Drive Recovery Factor B-45
T. G. Roberts
Calculation of Gas Reserves from Gas Density Data B-49
W. H. Mensch
"Modern Well Completion" Lectures Offered at University of Texas . B-57
Waterflooding in Eastern Kansas B-60
R. F. Lollar
Texas Mid-Continent Oil & Gas Association Announce
Meeting Speakers B-73
Production Fundamentals
Development and Evaluation of Gas-Condensate
Reservoirs — Part 5 . . . . . B-76
William C. Goodson
Hydraulic Perforating B-88
What's Behind These Crazy Oilfield Names? B-90
Pre-Registration Arranged for 19th AAODC Convention B-96
Petroleum Engineers to Hold 34th Annual Meeting in Dallas B-103
Los Angeles AIME Announces Fall Meeting B-103
Acid Treatments Yield to Engineering Design B-115
Texas Boasts First PE Coed Graduate B-120
Obtain Optimum Bit Life B-125
William K. Holstein
Service Barges Join Louisiana Coast Fleet B-142

REFINING AND PETROCHEMICAL

A Report on Continuous Contact Treatment C-6
Dr. E. R. Smoley
New Developments and Techniques in Delayed Coking C-7
V. Mekler and M. E. Brooks
The Fluid Process — Commercial Experience to Date C-15
J. McDonald and C. O. Rhys, Jr.
The Refining Engineer's Process Notebook C-19
Calculating Tank Heat Losses C-21
W. D. Cowell
A Haze on the Refinery Horizon C-30
L. F. Scheel
Programming Plate to Plate Distillation Calculations C-35
Dr. R. N. Maddox and J. H. Erbar

OIL AND GAS PIPELINING

Mexican Pipeliners Fight Swamps, Rivers, Mountains D-19
Mary Saint Albans
Transco Crosses Hudson River with Dual Lines D-22
Humble Modernizes Oil Pipeline Systems to Reduce Operating Costs . . . D-25
W. L. Moore and I. B. Cloessner, Jr.
Graphic Engineering Digests:
How PG&E Monitors Its Super-Inch for Rupture D-35
J. H. Stannard, Jr. and Tod Morcott
Selecting TV Equipment to Fit the Problem D-40
R. W. Hall
Developments to Watch D-41
Pipeline Fundamentals
Scheduling and Dispatching Crude Oil and Refined Products,
Part 2 . . . . . D-44
Fred Ashford, Jr.

FEATURES

The Course of Oil A-4
Advertisers' Index A-6
Petroleum Profile A-8
Edward L. Steiniger
The Conference Table A-10
Highlights A-12
Meetings A-14
Management Personals E-24
The Trade Parade E-36
Books to Read E-44
Laugh with Barney E-49
Of Things to Come in Oil B-3
What's Doing in Drilling B-104
Running Tour with Men in the Industry B-110
Exploration Activities B-116
New Drilling and Producing Equipment B-132
New Drilling and Producing Literature B-140
New Refining Equipment C-42
Refining Personals C-48
New Refining Literature C-52
Pipeline Projects D-50
With the Pipeline Contractors D-53
Pipeline Personals D-55
New Pipeline Equipment D-56
New Pipeline Literature D-57

Four Editions
Published Monthly by
The Petroleum Engineer
Publishing Company
800 Davis Building
Dallas 2, Texas

THE PETROLEUM Engineer
FOR MANAGEMENT
INTEGRATED EDITION OF THE PETROLEUM ENGINEER

THE PETROLEUM Engineer
DRILLING AND PRODUCING
SPECIALIZED EDITION OF THE PETROLEUM ENGINEER

REFINING Engineer
SPECIALIZED EDITION OF THE PETROLEUM ENGINEER

PIPELINE Engineer
SPECIALIZED EDITION OF THE PETROLEUM ENGINEER

What Made Energy Cheap?

SEVERAL YEARS AGO Senator Robert Kerr was on a radio panel that discussed the percentage depletion allowance and he got a hot reception. His inquisitors were erudite and used real fancy logic. His replies boiled down to the unconditional statement, "We wouldn't have oil without it."

Now Senator Kerr is a smart man and a practiced politician. He is adept at communicating his ideas to his fellowman. He knew and you know that you can write ten volumes on the depletion tax provision but you just can't get anybody to read it.

Only Congressmen and a few oil men wade through those statistics that have kept a percentage depletion allowance in the rules since 1926. But what can you tell the voting citizen who hears Congressman Cellar and Senator Douglas say we are losing $1 billion a year in taxes to rich oil men?

In the first place, get off the defensive. More than any one thing, the depletion allowance turned the United States from an oil have-not nation into the world's largest oil-producing country. Before 1926, Congress was concerned about not having enough oil to fuel the Navy; since the depletion provision, there has been no reason to worry.

EVERY COUNTRY IN THE WORLD where oil companies go has copied that kind of provision. They've learned from us that exploring for oil and developing it depend upon depletion allowances. You can't have your capital and eat it, too. In a gamble that costs as much as finding oil, you have to know you'll make more than utility rates or — assuming you have normal business sense — you'd go into some safe and sane project that is less chancey and has steady returns.

Our own petroleum resources have been doubled and trebled and quadrupled by technological progress. What do you think was the driving force? The carrot of depletion deduction in front of its nose pulled every company in the uphill struggle to recover two barrels of oil where one grew before. Can you think of any one provision that has done more for our economic progress than this promoter of cheap energy?

Yet at the very time when there is an exodus from the United States to other countries to find oil because of high costs and taxes, the Pied Pipers would whistle us into a cave of non-return.

THE GOOD OLD CARROT had us well prepared to fuel two world wars. If you want to get careless with tax figures, just imagine who would be collecting taxes if we hadn't had that lush oversupply of oil.

The depletion allowance has made oil and gas cheaper because of a constant oversupply (except during wars). And oil energy — cheap and available at every crossroads — sets the pace of all energy costs. Cheap energy has brought us to here. Is this the time to put a lid on energy resources? And, isn't it funny that the same fellows who want to shut down on exploration for oil and gas by squeezing the depletion provision are the same ones who want the taxpayers to finance atomic energy — at no matter what the cost?

As Senator Kerr said, it's plain and simple — without the depletion allowance, we'll have less and less oil at more and more cost. Period. That one sentence holds the truth. If you want to keep energy cheap you have to keep percentage depletion.

Ernestine Adams

Congrats and $25 for this quip to M. H. Barber, Continental Oil Co., Big Spring, Texas.

"told him to pack the pump"

Whether it's running casing for surface hole, intermediate string, oil string or tubing . . . Lone Star Steel pipe is the brand Joe Roughneck counts on. Centrally located in the heart of the Mid-Continent oil producing area, Lone Star delivers API electric-weld casing, tubing and line-pipe on the double . . . in quantity! And, you can depend on Lone Star for quality as well as quantity. Our ultra-modern steel mill is equipped with the newest, most efficient tools in the industry. Rigid quality control is maintained from ore to finished product.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.

Lone Star STEEL COMPANY

©1956 Lone Star Steel Company

EXECUTIVE—SALES OFFICES
W. Mockingbird Lane at Roper • P. O. Box 12226 • Dallas, Texas
DISTRICT SALES OFFICES
912 Republic National Bank Building, Dallas, Texas
Houston, Texas | Midland, Texas | Tulsa, Oklahoma

ADVERTISERS' INDEX

A

ACF Industries, Incorporated, W-K-M Division A-16b, B-2, D-39, D-49
Air Preheater Corporation, The D-4
Ajax Iron Works B-17
Allen-Bradley Co. A-9
Allis-Chalmers D-8, D-9
American Brass Company, The Buffalo Division C-24
American Machine and Foundry Company, The J. B. Beaird Company, Incorporated, Subsidiary E-33
American Meter Company E-25, E-37, E-41
American Recording Chart Company E-40
Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division D-5

B

Beach-Russ Division of Joy Manufacturing Company B-43
Babcock & Wilcox Co., The Refractories Division C-18
Tubular Product Division, Fittings Department C-43
Baker Oil Tools, Inc. B-18, B-38, B-39
Barber-Greene D-2
Bearid Division, National Lead Co. B-111, B-112
B & W, Inc. B-138
The J. B. Beaird Company, Incorporated, Subsidiary American Machine and Foundry Company E-33
Bethlehem Steel Company D-14, D-15
Black, Sivalls & Bryson, Inc. A-16
Blaw-Knox Company, Buflovak Division D-45
Brakeseal, Inc. E-46
Brown Oil Tools, Inc. B-7
Bucyrus-Erie Company D-17
Burndy D-12

C

Cable & Stephens B-116
Cameron Iron Works B-52, B-53
Caterpillar Tractor Company E-26, E-27
A. B. Chance Co. D-58
Chicago Bridge & Iron Company A-16a
Christensen Diamond Products B-83
Clark Bros. Co. D-26, D-27
Classified Advertising E-36
Continental Emsco Company, a Division of The Youngstown Sheet and Tube Company B-A9, B-A4, B-A5, B-A6, B-67, B-68, B-69, B-70
Colorado Fuel and Iron Corporation, The B-14, B-15
Cooper-Bessemer Corporation E-14, F-15
Core Laboratories, Inc. B-117
Crutcher-Rolfs-Cummings D-51

D

Darling Valve & Manufacturing Co. D-13
Dowell ..... Inside Front Cover — A-13
Dresser Industries, Inc. E-18, E-19
Drilling Accessory & Manufacturing Co., Inc. D-53
Du Pont, E. I., de Nemours Co., Inc. C-27
Dunmetallic Corporation C-50
Duriron Company, Inc., The D-23

E

Engineered Oil Tools, Inc. B-97
Emerol Manufacturing Co., Inc. B-142
Ethyl Corporation C-4, C-5

F

Fleetline Co. D-55
Floridin Company E-39
Foxboro Company, The D-30, D-31
Franks Division of Cabot Shops, Inc. B-106, B-107

G

Gardner-Denver Company B-128, B-129
Gaso Pump & Burner Mfg. Co. A-16f
Gates Rubber Co., The B-90, B-91
General American Transportation Corporation, Plate & Welding Division E-20
Graham Manufacturing Co., Inc. C-44
Grant Oil Tool Company B-8
Grove Valve & Regulator Company, A Subsidiary of Walworth E-47
Guiberson Corporation, The B-5
Gulf Coast Machine & Supply Co. B-119
Gulf Oil Corporation E-48

H

Halliburton Oil Well Cementing Company ..... B-1, B-51, B-85, Back Cover
Happy Company, The B-114
Harbison-Fischer Mfg. Co. B-105
Hardy-Griffin Engineering Corporation, A Division of Atlas Pipe, Inc. B-110
Hercules Tool Company B-135
H & L Tooth Company A-16d
Hotel Figueroa E-46
Hotel Pittsburgher E-36
Houston Oil Field Material Company, Inc. B-86
Houdry Process Corporation C-48, C-49
Hughes Tool Company B-100, B-101
Hycalog, Inc. B-132
Hydril Company E-35

I

Ingersoll-Rand C-23
International Harvester Co., Construction Equipment Division E-23

J

Jefferson Chemical Company, Inc. C-31
Jensen Bros. Mfg. Co. B-139
Johns-Manville Products B-16, D-6, D-7
Johnston Pump Co. B-139
Johnston Testers, Inc. B-13
The S. M. Jones Company, Division of Buffalo Eclipse Corporation B-75

K

Kerrigan Iron Works, Inc. C-51
Kittell Muffler & Engineering, Inc. E-44
KLM Royal Dutch Airlines E-45
Koppers Company, Inc., Tar Products Division D-10

L

Lamar Hotel E-42
Lane-Wells Company ..... Inside Back Cover
Larkin Packer Company, Inc. B-19
Liberty Manufacturing Company of Texas B-11
J. E. Lonergan Co. E-49
Lone Star Steel Company A-5
Lufkin Foundry & Machine Company B-93

M

Magnet Cove Barium Corporation B-71
Manufacturers Engineering & Equipment Corporation C-52
Manzel, a Unit of Houdaille Industries, Inc. E-43
The Marley Co. C-37
Marsh Instrument Co. E-21
John N. Martin, Manufacturer B-127
Merla Tool Corporation B-103
Miller Sand Pump Co. B-126
Mission Manufacturing Co. B-55
Motorola Communications & Electronics, Inc. D-18
M & V Tank Company B-126

Mc

McCullough Tool Company B-10

N

National Supply Company, The B-79, B-80, B-81, B-82
National Tank Company E-50
Nicolet Industries, Inc. D-11
Nordstrom Valve Division, Rockwell Manufacturing Company E-30, E-31
W. C. Norris, Manufacturer, Division of Dover Corporation B-87

O

Oakite Products, Inc. B-136, D-57
Oil Center Tool Co. B-74
Oil States Rubber Co. B-99
Oil Well Supply Division of United States Steel A-7
D. W. Onan & Sons, Inc. E-44
Orbit Valve Company B-109
Otis Engineering Corporation B-94, B-95

P

Pan Geo Atlas Corp. B-4
The Ralph M. Parsons Co. E-36
Peerless Manufacturing Co. A-13
Petreco, A Division of Petrolite Corporation C-2
Petroleum Electric Power Association E-28
Petro-Chem Development Co., Inc. E-32
Pipeline Cleaners Co. D-55
Pittsburgh Coke and Chemical Company 2
Plastic and Coal Chemicals Division, Allied Chemical D-1
Polyken Products, Division of The Kendall Company A-16c
William Powell Company, The C-33
Procon, Incorporated C-25

R

Radiator Specialty Co. C-51
Rector Well Equipment Company, The B-138
Reed Roller Bit Company B-122, B-123
Ridge Tool Company, The B-120
Rockford Clutch Division, Borg-Warner B-137
Rockwell Manufacturing Co. B-108
Roebling, Subsidiary of The Colorado Fuel and Iron Corporation E-29

S

Seamless Rubber Company, The D-54
Schlumberger Well Surveying Corporation B-133
Security Engineering Division B-54
Shaffer Tool Works B-89
Sheehan Pipe Line Construction Co. D-52
Shell Oil Company E-38
M. B. Skinner Co. C-50, D-56
Standard Oil Company of California E-17
Standard Oil Company (N. J.) E-34
Steel Forgings, Inc. D-55
Sun Ship Building & Dry Dock Co. C-1

T

Tapecoat Company, The D-3
Teletype Corporation, Subsidiary of Western Electric Company, Inc. D-32, D-33
Texas Employers Insurance Association A-1
Thornhill-Craver Company B-58, B-59
Tinker & Rasor D-58
Tretolite Division, The Petrolite Corporation B-78

U

Union Wire Rope Corporation, Subsidiary of Armco Steel Corporation B-130, B-131
United States Steel Stainless Steel C-3, C-28, C-29
Universal Oil Products C-40, C-41, D-16, D-37

V

Visco Products Company, Inc. B-6
Henry Vogt Machine Co. A-16h

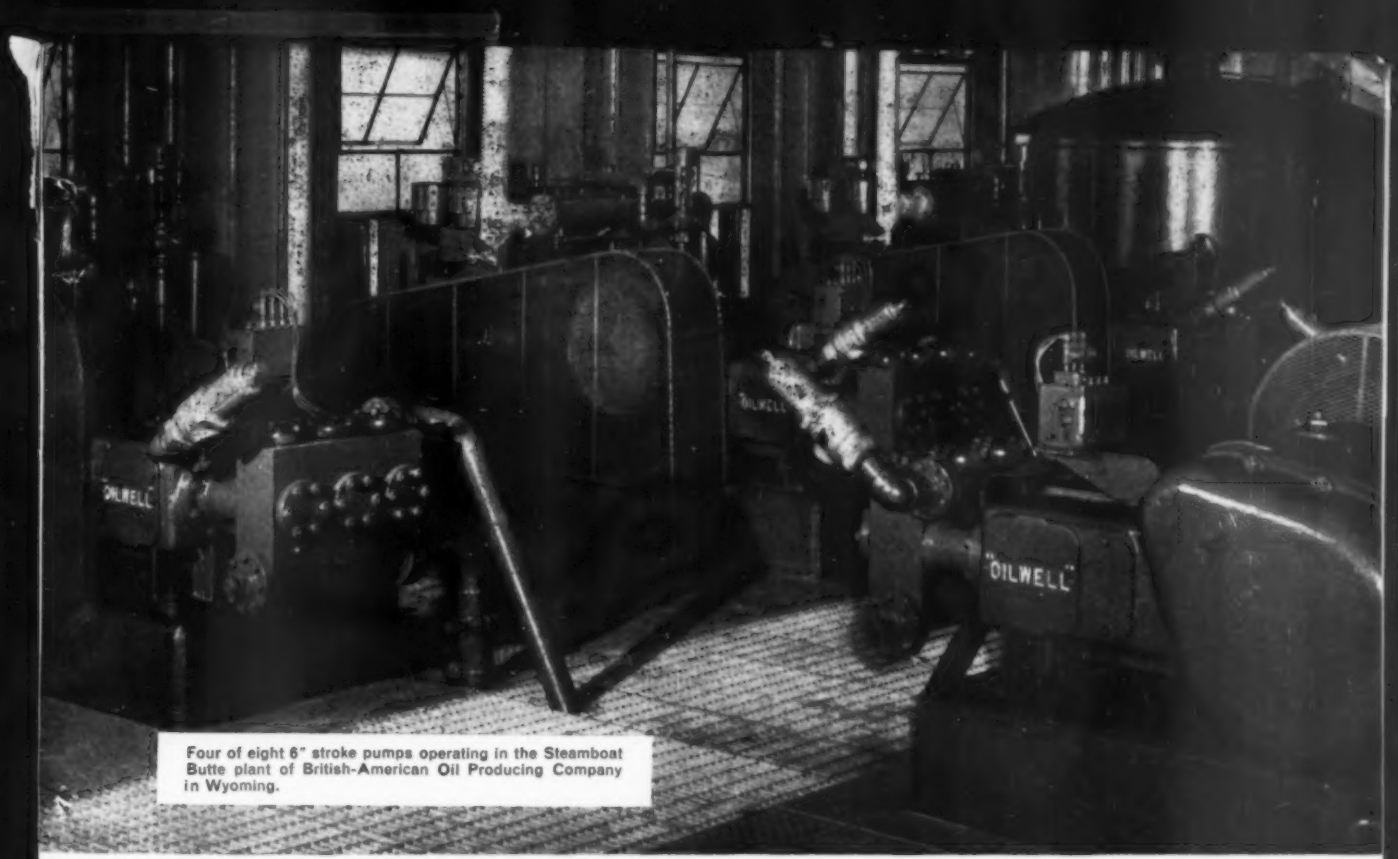
W

Warner-Lewis Company C-34
Waukesha Motor Company B-12, B-102
Welex, Inc. B-98
Well Equipment Mfg. Co. B-124
Western Company, The B-121
Whitney Chain Company B-134
Wheland Company, The B-141
T. D. Williamson, Inc. D-47
Williams Brothers E-42
W-K-M Division of ACF Industries, Incorporated A-16b, B-2, D-39, D-49

Y

Yarnall-Waring Company C-47

THIS INDEX IS PROVIDED AS AN ADDITIONAL SERVICE FOR OUR READERS — THE PUBLISHER ASSUMES NO RESPONSIBILITY FOR ERRORS OR OMISSIONS



Four of eight 6" stroke pumps operating in the Steamboat Butte plant of British-American Oil Producing Company in Wyoming.

Here's recorded performance of 8 "Oilwell" Water Injection Pumps . . . on the job 5 years!

THE British-American Oil Producing Company has eight "Oilwell" Triplex Plunger Pumps in its pressure-maintenance plant at Steamboat Butte, Wyoming. These pumps have been in operation for five years . . . and their cost-and-service record is outstanding.

These pumps have injected over 37,000,000 barrels of water at pressures from 560 psi to 735 psi with no major pump repairs. Total maintenance during the five years of operation has amounted to 0.09 mills per barrel. On six pumps, valves and seats required replacement; on two pumps, scored plungers were replaced; and certain packing and oil seals have been replaced. Stainless steel valves and seats, installed as original equipment in two pumps, are still in service after five years.

Excellent care and supervision in maintaining proper operating conditions have contributed to the economical functioning of the pumps.

USS and "Oilwell" are registered trademarks

Average downtime per pump—
4.2 hours per year

Average parts cost per pump—
$86.14 per year

Here are the detailed facts:

Repair parts for five years	$ 3,445.50
Average repair parts per pump	$ 430.69
Average repair parts per pump per year	$ 86.14
Total downtime in five years	168 hours
Average downtime per pump	21 hours
Average downtime per pump per year	4.2 hours

Your "Oilwell" representative can give complete information on these or other plunger pumps which can give you similar service in waterflood applications. Be sure to contact him while your project is in the planning stage. His application experience will be helpful.

Exterior view of the Steamboat Butte plant.

USS **Oil Well Supply Division of United States Steel**

Executive Offices—Dallas, Texas
Export Office—30 Rockefeller Plaza, New York 20, N. Y.

Petroleum Profile

IF YOU ASK EDWARD L. STEINIGER how he got into the oil business, he'll quickly tell you: "A friend told me more than 25 years ago that Sinclair was a good place to work."

However, his rise to president of Sinclair Oil Corporation was not simple when you consider he spent 20 years in foreign operations.

Steiniger, born on the lower West Side of New York's Manhattan Island, attended Pace College and New York University. He majored in business administration. His first job was in the cost accounting department of Consolidated Steel. Price Waterhouse & Company, the noted accounting firm, was the next step and one that eventually brought him to the top of Sinclair.

While on assignment with Price Waterhouse, he took the advice of his friend and applied for a job with Sinclair. That was in 1925 when he was hired as an office assistant in the exploration company. His tenure at the company's home office was short. In 1928 Steiniger was moved to Venezuela, where small subsidiaries of Sinclair were surveying and testing oil concessions in what was then a country with little development.

His stay there coincided with Venezuela's rapid growth to the world's second largest producer of petroleum. During this period, he acquired a strong background in all company activities — exploration, production, pipeline, refining and marketing.

A naturally inquiring individual, Steiniger made it a point to make himself thoroughly familiar with Venezuela. He traveled extensively throughout that petroleum-rich nation. He utilized all types of transportation, including dugout canoe, launch and even mule back. Steiniger and Sinclair representatives explored thousands of square miles in eastern, central and western Venezuela.

In 1936, he returned to New York to set up financing for a drilling program. He went back to Venezuela in 1940 as vice president of the Venezuelan subsidiary, which, five months later, made its first big strike.

Steiniger supervised the construction of a 100-mile pipeline to the Caribbean coast, the construction of terminal and docking facilities and, finally, a refinery to process the crude oil. He was elected president of the subsidiary in 1950 and at the same time got the job of selling products made by the refinery.

In 1937, he married Joan Bergin. He refers to her as his "vice president in charge of hospitality." In foreign jobs, Steiniger comments, the woman usually does just as much work as the man.

The Steinigers now live in the seventies, just off of New York's famed Central Park, with their two children, Pamela, 11 and Gerald, 9.

Steiniger was elected a Sinclair vice president in charge of foreign operations in 1955. Two years later he was named executive vice president in charge of all operations and last year was elected president.

Sinclair is much different from the company that Steiniger joined in 1925. P. C. Spencer, now chairman of the board and chief executive officer, made a number of management changes when he succeeded the dynamic Harry F. Sinclair, who founded the company in 1916. Under Spencer's leadership, Sinclair, as measured by assets, moved into the billion-dollar class. Spencer also was responsible for setting up a management team program with responsibility delegated to individual managers. Steiniger also believes in this same philosophy.

EDWARD L. STEINIGER

President

Sinclair Oil Corporation

Steiniger's professional outlook is global. He is a strong supporter of continued imports, but at the same time he does not in the slightest discount the domestic oil industry. He points out that shipments of foreign oil must be balanced so they do not hurt the domestic industry or threaten defense requirements. He further argues that the limited nature of this nation's reserves makes the use of foreign oil imperative. Reserves are dwindling sharply in terms of annual consumption requirements and should be conserved for future needs.

If you ask Steiniger, "What is the key to success?", he will strongly advise you that the best experience for any young man going into the business world is to work a few years in foreign service, be it in oil, or what have you.

When Steiniger finds time, he likes to ice skate and ski. His favorite summer pastimes are boating and swimming. His time for these is limited, however, because he spends long hours on the job, being usually one of the first to arrive at Sinclair's headquarters and the last to leave.

His favorite charities are the New York Foundling Home and New York Catholic Charities. He holds the rank of Grand Cross in the Order of the Holy Sepulchre and is a lay trustee of Fordham University. This year he received an honorary degree of Doctor of Commercial Science from Pace College.

He is a director of the American Petroleum Institute and also a board member of the National Industrial Conference Board. He belongs to the Pan-American Society, the Newcomen Society, and in New York to the New York University Club, Shenorock Shore Club of Rye, Union League Club, and the Economic Club.

A-B QUALITY

ALLEN-BRADLEY
Solenoid Starters give
MORE MILLIONS OF TROUBLE FREE OPERATIONS

. . . and for good reasons

• ONE MOVING PART
With this simple solenoid design, there's virtually nothing to go wrong—all trouble-causing bearings, pivots, and flexible jumpers have been eliminated.

• DOUBLE BREAK, SILVER ALLOY CONTACTS
Allen-Bradley silver alloy contacts never require maintenance. They are always in perfect operating condition . . . and remain so until completely worn away.

• SIMPLE UP-AND-DOWN MOTION
The virtually frictionless, straight line vertical motion provides uniform contact pressure at all times—and assures consistent, rapid operation of the contactor.

• RELIABLE OVERLOAD PROTECTION
All A-B starters are equipped with two permanently accurate and reliable overload relays that protect motors against "burnouts." Three overload relays can be furnished.

BULLETIN 709 STARTERS are made in 9 sizes from Size 0 (at left) up to Size 8.

BULLETIN 709 SIZE 7 with maximum ratings of 300 hp, 220 v; 600 hp, 440-550 v.

ALLEN-BRADLEY

Allen-Bradley Co., 214 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY MOTOR CONTROL

THE CONFERENCE TABLE

The United States has never lost a war or won a conference. — WILL ROGERS

Proposals for Brazil's Petroleum

The President of the National Economic Development Bank of Brazil proposed on a television program that the Government permit private capital, both domestic and foreign, to explore for petroleum in undeveloped areas in Brazil. Successful production by private companies would be paid for in royalties to the State and to Petrobras, government company, allowing the latter to concentrate all its efforts on proved areas. Under existing laws only Petrobras can explore and produce petroleum in Brazil.

D&D Speakers

Dr. Frank B. Conselman, consulting geologist in Abilene, Texas, and Michel T. Halbouty, consultant, Houston, will be speakers when members of Desk and Derrick Clubs in the United States, Hawaii and Canada convene in San Antonio, Texas, for the eighth annual convention, October 2-3. Miss Maxine R. Hacke, immediate past president, Warren Petroleum Corporation, Tulsa, will make the keynote address. These announcements come from Miss Ellen M. Vaughan, The Carter Oil Company, Shreveport, Louisiana, Association president. Some 1500 oil women are expected to attend this annual event.

★ *Character is what you are in the dark.* —Dwight L. Moody

Oil Problems in H-Bomb War

One of the most critical problems involved in a hydrogen bomb attack would be the immediate availability of oil, warns Leo Hoegh, director of the Office of Civil and Defense Mobilization. The government, acting through the Interior Department has presented an outline for oil and gas mobilization to the National Petroleum Council, and is expected to point out specific individuals in the oil industry to act as "executive reserve" personnel who could act to administer war-oil programs at national, state and local government levels. Hoegh warned the industry that since only a 3-hour warning, at most, could be given, local areas would have to meet their supply and demand problems by themselves for at least a month. "Our studies have indicated the availability of petroleum products as one of the most critical problems — if not the most critical," said Hoegh.

★ *In the ideal sense nothing is uninteresting; there are only uninterested people.* —Brooks Atkinson

Threatened Solvency

Opposing further taxation of oil and gas firms, the president of Phillips Petroleum Company released a statement recently that we think should be spread far and wide.

K. S. Adams said:

"The oil and gas industry and corporations cannot absorb further increases in taxes without seriously impairing their ability to stay in business, to say nothing of creating new sources of employment, income and taxation," Adams said. "Phillips already pays over $12 million annually to the State of Texas in taxes.

"It is not correct to say that corporations such as ours are making excessive profits. In fact, the profit margin is becoming dangerously close.

"In an attempt to stay even over the past four years in total earnings, Phillips had to increase its investments 40 percent. Our return on investment last year was only 5.66 percent. This has to cover amounts plowed back into the business to keep it going and pay stockholders some return on their money.

"Based on our dividends last year and recent market quotations, the yield was only 3.3 percent to Phillips stockholders. Our experience is typical of the oil industry.

"Increased taxes on industry could have dangerous consequences on the industrial growth and rising payrolls which have favored Texans."

★ *People who advertise their troubles never seem to dispose of their stock.*

Canadian Energy Board Set Up

Control over import and export of gas in Canada, including hydrocarbons, and export of electric power will pass to the National Energy Board, to be established within the Federal Government. The new board will take over the gas and power controls formerly vested in the Minister of Trade and Commerce and Board of Transport Commissioners. The Energy Board will now have regulation of the pipelines, including oil lines, and will also acquire reserve power to regulate oil import and export.

★ *Three things are good in little measure and evil in large; yeast, salt and hesitation.* —Talmud

Hogan Joins Drilling-Producing Staff

Walter A. Hogan has joined the staff of the Drilling and Producing edition of *The Petroleum Engineer* as field editor.

As a former associate editor of *Offshore* oil magazine, Hogan has covered drilling operations along the Gulf Coast, and has developed many news sources in that area.

Most recently, Hogan was an account executive for Womack & Snelson Advertising, Midland-Odessa, preparing advertising and trade publication articles for oilfield supply and service companies in the Permian Basin.

As information services officer for the USAF, Hogan conducted a promotion program that received recognition as being instrumental in making Florida's reserve troop carrier wing the most fully-manned in the nation.

Hogan received a journalism degree, including a science background, from the University of Texas in 1953.

He comes from an oil family, his father being an old-timer with Magnolia Pipe Line Company. Hogan was born in Fort Worth, and has lived in "every oil patch in Texas from Comanche County to Cut 'n Shoot, and points beyond."

Lowell Murphy, formerly field editor for the Drilling and Producing Edition, will step up to the post of assistant editor, replacing C. R. Graham who recently joined *Petroleum Equipment* as editor.

Reds Youths Have Bad Time

Remember the trouble the Red-Sponsored World Youth Festival had when they met in Vienna, Austria, in July. The anti-Communists, mostly young Austrians, waged street fights and distributed leaflets against Communism. The Red youths called police to help them.

Austria is just not a good place for World Youth Festivals. It's a country that has had a bellyfull of Reds. One event came out in an interview with Dr. Margarethe Ottillinger, the charming and brave vice president of OMVAG, Austrian state oil company. (See Page E-8.) We'd be surprised if Dr. Ottillinger wasn't an advisor to anti-Communist youth. She isn't only a highly intelligent woman, she's a stalwart believer in freedom.

★ *You can lead a man up to the university, but you can't make him think.* —Finley Peter Dunne ("Mr. Dooley")

Commemorate the Centennial

Atlantic Refining Company used pictures of the historic Drake well at Titusville, Pennsylvania, for its outdoor poster advertising during July and August. States a brochure the company distributed: "A century after Col. Drake's discovery, only one percent of America's physical work is done by man himself. The rest is done by machines, and petroleum provides more than 70 percent of the energy that activates those machines."

In *The Flying Red Horse* (Socony Mobil Magazine) was a report by a young newspaperman and his wife who lived for a week in a Connecticut town that had been re-created by an historical society. This pre-petroleum existence was described in "We Lived in 1859." You can be sure of one thing — it wasn't easy.

One Weapon Is Trade

"The Russians are using trade as a weapon. The United States will be priced out of the world market if we do not recognize the Soviet use of world trade as a cold war weapon and meet the threat by dealing with the problem of rising costs and inflation here in America."

— Vice President Richard Nixon

Unions Not for Engineers

On Page E-16 is an article on results of a survey of engineers about the advisibility of an engineering union. After an article recently on the subject we received the letter below . The reference to "poison" is a statement by an AFL-CIO staff member who said engineers and scientists are "deeply poisoned" by management and engineering schools.

"As a 'poisoned student' in a college taking petroleum engineering, I was quite interested in your article telling the 'truths' about Unionization of Engineers.

"I know no competent, efficient engineer would rely on a body of individuals to regulate himself or his profession. If there is no self discipline in an individual, then that individual has no business being in the Engineering profession. If this is what the Labor Unions are talking about when they tell of 'poisoning minds' in college then they are right. Colleges tend to make an individual think for himself and rely upon himself.

"Granted that as a group engineers are not paid on the same scale as a machinist or carpenter but engineers have not lost, as yet, the freedom that the carpenter and machinist once had. The limit to which an engineer can advance is directly proportional to his merits and his ambitions. Also, an engineer at the age of 60 or 80 will be a better engineer than at the age of 30. Can any laborer say the same?

"As a student I have worked in four phases of the petroleum industry: drilling, producing, pipelining, and as an engineer-in-training for a natural gas company. At none of these four places or at college where I am a senior has there been any attempt to influence me one way or another, for or against unions. If I am to be poisoned, please tell them to hurry. I would enjoy discussing this with any or all of them.

"I, for one, am and plan to continue to regard myself and my colleagues as professional people, not employees. I belong to the Profession of Engineering."

James E. Cornett
Houston, Texas

Import Rules

We can say one definite thing about the mandatory import controls — they have stimulated the manufacture of paper. Directives are issued, lists of individual oil import allocations are released, then come appeals of separate companies showing why their shares of total imports are unrealistic. Following that is usually a review of the appeal by the board and a statement of why the appeal was denied.

The more papers we see and read, the more we incline toward the tariff theory. Slap a $1 a barrel duty on oil imports and cut out a mountain of paper work. We are producing paragraphs instead of profits.

Who can figure how much we'll save in legal fees, writing time, paper, typing effort, etc., if we rescinded the red tape and paid duty on imported oil? That way Uncle Sam also would be collecting money instead of running up a bill for legal documents and hair-splitting decisions.

We've always plugged for the simple way of running things — and not just because we understand it better. We have a suspicion that most of you do, too.

Petroleum Engineer in Time Capsule

The Petroleum Engineer issue for August, called "A Century Ahead" was among the mementoes placed in the Time Capsule buried at Titusville August 27. The special issue had predictions by leading authorities on the petroleum industry and the nation in 2059. We don't guarantee the prophesies will come true, but we're downright positive they'll be interesting to the reader in the year 2059.

Engineers Pay Increases

The number of job offers to University of Michigan engineering students has increased and may go higher, reports Professor John G. Young. A sampling of the offers indicates salaries are up about 5 percent, with a Bachelor's degree graduate at about $505 per month, a Master's at about $600, and a PhD at around $780. A total of 556 known job offers to 352 students have been made during the present period, averaging about 1.7 offers per student.

Highlights ★ ★ ★

Awards Proposed for Science

Approval of a national program to recognize outstanding individual contribution in the fields of engineering and science has been given by the House Committee on Science and Astronautics. Purpose is to encourage effort in engineering and scientific pursuits, encourage individuals to embark upon engineering and scientific careers and to focus public attention on national needs in engineering and science.

The program of Federal recognition authorized by the Committee would take the form of an appropriate medal to be presented annually by the President to not more than 20 individuals who have outstanding records in engineering or scientific achievements. In addition to the medal, each recipient would receive up to $10,000 as a tax-free stipend.

New Helium Laws Proposed

The Department of the Interior renewed its request for congressional legislation that would enable it to carry out a long-range plan for conserving helium, the lightweight nonflammable gas essential to atomic-energy and missile programs. Interior wants authority to recover and store for future use some 32 billion cubic-feet of helium which otherwise would be lost when natural gas containing it is burned as fuel.

Interior's helium-conservation program calls for construction of up to 12 new plants, to be located on natural-gas pipelines and to extract helium from the natural gas before it goes to fuel markets. The helium thus recovered would be stored underground in the Government-owned Cliffside gas field near Amarillo, Texas until needed.

Oil Change Verdict

Official crankcase oil change recommendation of the Marketing Division of the American Petroleum Institute is "in winter every 30 days, in summer every 60 days, but never to exceed 2000 miles." This recommendation is official, replacing the previous one which was somewhat longer.

Vickers Petroleum Decentralizes

Initial phase of a decentralization program has been completed by The Vickers Petroleum Company, Wichita, Kansas. Keynote of the program is the move of the 41-year-old firm's exploration, production and research departments along with the offices of J. A. Vickers, president, from Wichita to new quarters at 1700 Broadway, Denver, Colorado. General offices of the company will remain at Wichita.

Mobil Combines Socony Affiliates

Operations of the principal wholly-owned affiliates of Socony Mobil Oil Company, Inc., in the United States are being combined with the parent company's domestic operations into a single coast-to-coast operating unit, Mobil Oil Company. This was announced by Albert L. Nickerson, president of Socony Mobil, and Herbert Willetts, president of Mobil.

The transfer of operations will affect three affiliates: Magnolia Petroleum Company in the Southwest, General Petroleum Corporation in the Far West, and Mobil Producing Company in the north-central and Rock Mountain states. The operations that these affiliates have carried on will become the direct responsibility of Mobil Oil.

The changes are part of a new over-all organization plan, the first steps in which were taken by the Socony Mobil management more than two years ago. The plan went into effect for the company's top corporate structure and for its international operations on March 1 of this year.

No change in the ultimate ownership of any properties is involved. Magnolia and General Petroleum have been wholly owned by Socony Mobil for more than 30 years, and Mobil Producing was organized by Socony Mobil in 1954. Socony Mobil is owned by 207,000 shareholders, with no individual holding as much as one percent of the stock.

J. L. Latimer, now president of Magnolia, and R. L. Minckler, now president of General Petroleum, will continue as senior vice presidents of Mobil Oil Company.

Fred H. Moore, now executive vice president of Magnolia, will become vice president of Mobil Oil in charge of exploration and producing. Henry L. Waszkowski, now a vice president of Mobil Oil will become general manager of the Socony Mobil corporate exploration and producing department. R. Rea Jackson, now vice president of Mobil Oil in charge of refineries, will become vice president in charge of manufacturing and distribution.

Changes Name

Stockholders of White Eagle Oil Company, Tulsa, voted to change the corporate name to Helmerich and Payne, Inc., the name of a principal operating division of the company. This resumes a tradition of 40 years standing during which the name of Helmerich and Payne, Inc. acquired prominence as a drilling contractor and independent oil producer.

Western German's Demand Higher

Consumption of oil products in the first quarter of 1959 in Western Germany amounted to 5,277,123 tons plus 429,-986 tons of bunker oil sold to ships of all flags. This exceeds the figure of the first quarter of 1958 by 26 percent.

Mike Benedum Dies

THE GREAT WILDCATTER is dead. Michael Late Benedum spent some 70 years finding oil and at his death July 30 his interests included large scale exploration projects in both hemispheres. He is reputed to have discovered more oil than any man in history and to have made $100 million in his fabled career. How many millions he gave away nobody knows.

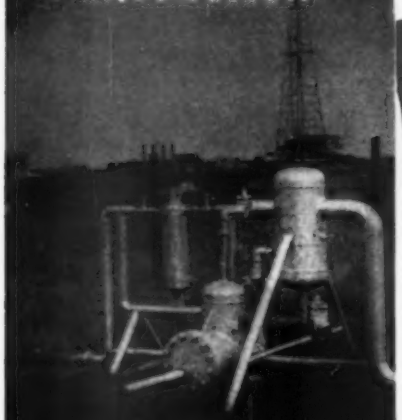
Mike Benedum's long history (he was born July 16, 1869, at Bridgeport, West Virginia) is almost the history of the petroleum industry. The thrilling story of his life is covered in Sam Mallison's "The Great Wildcatter" published in 1953. Mr. Benedum was the subject of a Petroleum Profile in *The Petroleum Engineer* for July, 1957.

Mike Benedum went to work at $25 a week running a grist mill. In the oil business he was associated usually with Joe C. Trees. The two went prospecting over the United States and into foreign lands.

A devout Methodist, Mr. Benedum never cursed and never gambled (except on wildcats). Much of his philanthropy went into works for his church and his native community.

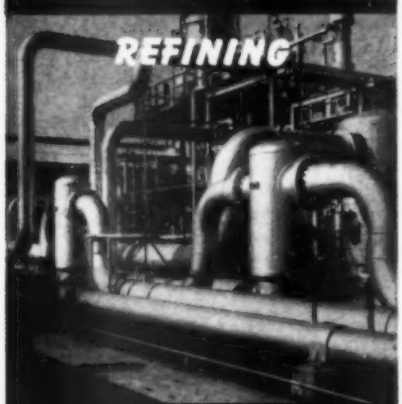
Benedum-Trees Oil Company, Pittsburgh, was his principal firm; others include Plymouth Oil Company, Hiawatha Oil and Gas, Mel-Ben Oil, Penn-Ohio and Bentex.

PRODUCTION



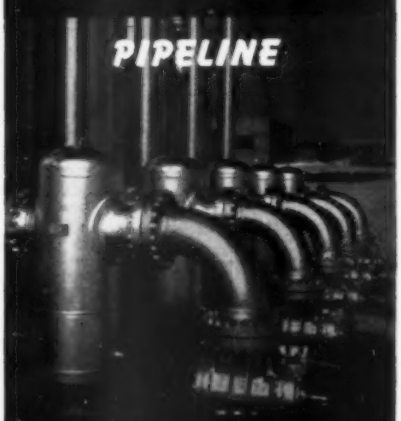
Pictured above is a Peerless Line Separator removing moisture from fuel to drilling rig.

REFINING



These two Peerless Line Separators are doing an efficient job of mist extraction in the Petrochemical plant in Kentucky.

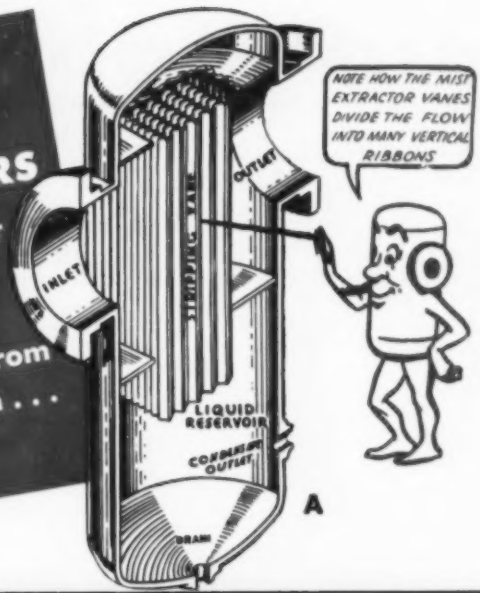
PIPELINE

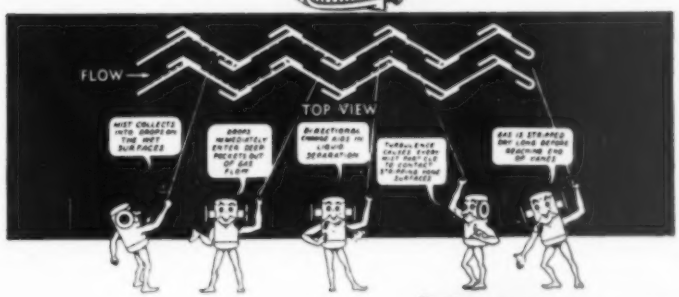


FIVE Peerless Line Separators are shown above as they handle carry over from large scrubbers.

PEERLESS LINE SEPARATORS

Outstanding for the efficient extraction of liquid mist from gas or steam . . .





HIGH EFFICIENCY—HIGH CAPACITY LOW PRESSURE DROP

Thousands of installations throughout the oil industry . . . production, pipeline, refining and petrochemical . . . prove the Peerless Line Separator principle to be one of the most outstanding methods available for the extraction of liquid gas, steam or air.

Drawing A above shows the arrangement of the vanes in the Separator. Drawing B is an illustration of the Peerless Principle.

The mist extractor combines the forces of impingement, centrifugal motion and surface tension to obtain its high efficiency. The path of the gas, etc., through the unit is constantly bending causing semi-violent turbulence and rolling of the gas against the walls of the vane. Impingement and centrifugal force combine to contact the droplets with the vanes, where they coalesce, and surface tension then causes them to cling to the vane's surfaces. Gravity and the impact of the gas steam then drive the droplets into the pockets where they roll down the vanes and out of the gas stream.

Through the Peerless method of mist extraction, the gas is stripped dry long before reaching the end of the vanes.

there's A PEERLESS SEPARATOR FOR EVERY REQUIREMENT

For any capacity
For any working pressure
For corrosive conditions
With removable vane units
With extra body length
With connections for accessory equipment
For pressure drop requirements of less than 6" water
For any vapor-liquid ratio
For any piping requirement

SPECIAL DESIGN SEPARATORS FOR ANY REQUIREMENT

FOR FURTHER INFORMATION ON THE USE OF PEERLESS LINE SEPARATORS PLEASE WRITE FOR NAME OF NEAREST PEERLESS ENGINEER.

PEERLESS MFG. CO.

"OVER 20,000 SEPARATORS and SCRUBBERS IN SERVICE"

PEERLESS MANUFACTURING CO.

P. O. BOX 13165 ★ DALLAS 20, TEXAS ★ FLeetwood 2-8431

REPRESENTATIVES IN ALL PRINCIPAL CITIES

Highlights

★ ★ ★

Aramco's Dilemmas

Arabian American Oil Company has a lot of natural gas to sell in Saudi Arabia. The firm has begun its sales program in a color brochure to attract possible chemical industries or any other business that can use cheap gas. If you could only get production and sales together, gas would be easy to sell.

Aramco ran into another dilemna recently that is going to be a little hard to solve.

A court barred the company from applying religious tests in hiring employees, and said that if the company can't comply it should "go elsewhere to serve your Arab masters."

State Supreme Court Justice Henry Epstein upset a state administrative ruling that allowed the oil firm to quiz prospective employees about their religion. He said the upholding of American justice outweighed any considerations of the company's relations with governments in the religious-tense Near East. The Arab lands are predominantly Moslem, with keen antagonisms toward Jewish Israel.

Interstate Compact Extended

The U. S. Senate and House of Representatives consented to a 4-year extension of the "Interstate Compact to Conserve Oil and Gas." The compact was first consented to by Congress in August, 1935 and has been subsequently approved since that time. Originally signed in Dallas, Texas, on February 16, 1935, when six states ratified the agreement, it has grown to 30 member states and 2 associate member states.

Companies Merge and Expand

Mergers and purchases to enlarge various petroleum companies have been numerous recently. Here are some:

One of the most important is Tidewater's proposed merger with Skelly Oil Company. Tidewater has filed a report with the Department of Justice regarding the merger. Both companies have exploration and development operations, manufacturing, transportation and marketing. Together they will cover large areas in the United States and abroad.

Sunray Mid-Continent has acquired sufficient shares of Suntide Refining so that it now owns more than 90 percent of the outstanding Suntide shares. It is expected that Suntide will operate as a direct subsidiary of Sunray; no changes in the operating management are contemplated.

Royal Dutch Petroleum Company and Shell Transport and Trading Company have acquired Canadian Eagle Oil Company, Ltd., a Toronto, Canada, firm.

Occidental Petroleum Corporation has merged with Gene Reid Drilling, Inc., of Bakersfield, California. Gene Reid, drilling company president, was elected to the board of directors of Occidental, and will serve as executive vice president. Dr. Armand Hammer is Occidental president. Also Occidental was approved for listing on the American Stock Exchange of New York. The company was organized three years ago and its shares in that time have increased from about $200,000 to approximately $10 million.

Ohio Oil Company acquired Aurora Gasoline Company in exchange for 874,422 shares of its common stock. Aurora operates refineries at Detroit, Muskegon, and Elsie, Michigan, and it markets throughout Michigan.

Murphy Corporation of El Dorado, Arkansas, through its affiliate Murphy-Canada Oil Company, acquired ownership of Vigor Oil Company, Ltd., a marketing concern. In addition, Murphy has entered into an agreement with Burmah Oil Company, Ltd., of Glasgow and London, for certain cooperative efforts in exploration in the Western Hemisphere and possibly in other areas. This is the first move by Burmah into the Western Hemisphere. Burmah is one of Britain's oldest oil organization, discovering oil in Burma about the turn of the century. Its operations are in India, Burma, Pakistan, and the Middle East.

American Petrofina acquired marketing properties of Colonial Petroleum Company, Des Moines. Included in the transaction are 40 retail outlets and 3 bulk plants in a four-state area.

Lift Lube Restrictions

The British Government has lifted its licensing restrictions on dollar lubricating oils. Lubricating oils were just one of a wide range of dollar goods released from controls to stimulate trade.

Meetings

Sept. 16-18—National Petroleum Association, annual meeting, Traymore Hotel, Atlantic City, N. J.

Sept. 17 — Natural Gasoline Association of America, Rocky Mountain regional, Gladstone Hotel, Denver, Colo.

Sept. 21-23 — American Society of Mechanical Engineers, petroleum mechanical engineering conference, Rice Hotel, Houston, Texas.

Sept. 21-Oct. 30 — School of Petroleum Technology, API Division of Production, Kilgore College, Kilgore, Tex.

Sept. 23-24 — Western Petroleum Refiners Association, Rocky Mountain regional technical-industrial relations meeting, Henning Hotel, Casper, Wyo.

Sept. 27-30 — American Petroleum Institute, executive committee of board of directors, Greenbrier Hotel, White Sulphur Springs, W. Va.

Sept. 28-Oct. 1 — The American Welding Society, fall meeting, Sheraton-Cadillac Hotel, Detroit, Michigan.

Sept. 29-30 — Western Petroleum Refiners Association, management seminar, Western Hills, Wagoner, Okla.

Sept. 29-Oct. 1 — National Association of Corrosion Engineers, western region, Bakersfield, Calif.

Oct. 1-2 — National Association of Corrosion Engineers, southeast region conference, Jacksonville, Fla.

Oct. 2-3 — Desk & Derrick Clubs of North America, annual convention, Hilton Hotel, San Antonio, Tex.

Oct. 4-7 — Society of Petroleum Engineers of AIME, annual fall meeting, Dallas, Texas.

Oct. 5-7 — American Gas Association, convention, Conrad Hilton Hotel, Chicago, Ill.

Oct. 5-8 — National Association of Corrosion Engineers, northeast region conference, Lord Baltimore Hotel, Baltimore, Md.

Oct. 5-Nov. 13 — School of Drilling Technology, American Assn. of Oilwell Drilling Contractors, Odessa College, Odessa, Tex.

Oct. 7-8 — Western Petroleum Refiners Association, annual waste disposal and pollution conference, Broadview Hotel, Wichita, Kans.

Oct. 8-9 — California Natural Gasoline Association, annual fall meeting, Huntington-Sheraton Hotel, Pasadena, Calif.

Oct. 8-10 — American Association of Petroleum Geologists, annual meeting of the Southwestern Federation of Geological Societies, Lubbock, Texas.

Oct. 11-13 — American Association of Oilwell Drilling Contractors, annual meeting, Skirven Hotel, Oklahoma City, Okla.

Oct. 11-15—American Society for Testing Materials, committee D-2 meeting, Sheraton-Palace Hotel, San Francisco, Calif.

Oct. 12-16—National Association of Corrosion Engineers, south central region conference, Cosmopolitan Hotel, Denver, Colo.

Oct. 19-23 — Petroleum Landman's Institute, University of Oklahoma, extension division, Norman, Okla.

Oct. 20-22 — National Association of Corrosion Engineers, north central region conference, Cleveland, O.

Oct. 22-23 — Society of Petroleum Engineers of AIME, Los Angeles Basin section, fall meeting, Huntington-Sheraton Hotel, Pasadena.

Oct. 23 — Natural Gasoline Association of America, southern regional meeting, Carlton Hotel, Tyler, Texas.

Oct. 25-27 — Independent Petroleum Association of America, annual meeting, Statler Hilton Hotel, Dallas, Texas.

Oct. 28-29 — Western Petroleum Refiners Association, annual session on refining technology, Rufus Garrett Hotel, El Dorado, Ark.

NEW ENGINEERING DEVELOPMENT

Dowell Announces the "Acid Guide"

Now available to you—a new, greatly improved method for planning and predicting the results of oil well acidizing treatments. The "Acid Guide," developed and now in use by Dowell, offers you an engineering basis for answering these questions:

1. **Is an acid treatment advisable?**
2. **What acid treatment would be best—kind of acid, addition agents, volume, injection rates, other considerations?**
3. **What results can I expect?**

Field results show an amazingly high degree of correlation with answers calculated from the "Acid Guide." You get this sort of information only from Dowell.

Today, when you ask your Dowell representative to **engineer** an acid treatment with the aid of the "Acid Guide," the chances are good that he will recommend an entirely different treatment than you expect. Acid volumes may be either smaller or larger. A different kind of acid may be recommended. Higher injection rates may be considered. As a matter of fact, the Dowell engineer may recommend fracturing or other treatments instead of acidizing.

In any case, field results indicate that you are likely to get more profit from your acidizing dollar.

Key to the "Acid Guide" is an "acid index number" which varies with the formation and the type of acid. Using this number as a basis, it is possible to select the most efficient treatment and to predict the probable results. The idea is to open up the largest possible drainage area at the lowest possible cost—by giving you the deepest possible penetration of the acid before it spends. This is achieved by balancing the amount and kind of acid and the injection rate against the solubility of the formation.

For example, Dowell engineered a treatment for a well completed in the Strawn Lime of Midland County, Texas. This formation is found at about 11,000 feet and is tight, dense, and almost completely soluble. The well did not produce at all after perforating. 360 gallons of BDA* (Breakdown Acid) was applied to clean the face of the pay, and production went to 27 bopd. The allowable is 180 bopd.

The "Acid Guide" showed that, under the existing well conditions, the optimum treatment was 12,000 gallons of Retarded Acid. It also showed that the maximum amount of regular acid that would be helpful was 2,000 gallons. The operator elected to treat the well with the 2,000 gallons of regular acid. Production rose to 53 bopd. Because of these results, the operator decided to try a 4,000-gallon regular acid treatment. However, as had been predicted with the "Acid Guide," there was no further increase in production.

Then the operator decided to follow the "Acid Guide." 12,000 gallons of Retarded Acid was injected at 5⅓ bbls. per minute. Production rose to 84 bopd. **The $3,500 cost was paid out in two months.**

That is just one example of the way the "Acid Guide" is increasing profits for operators. This engineered approach to acidizing is available **only** from Dowell, and is provided to you at no extra cost.

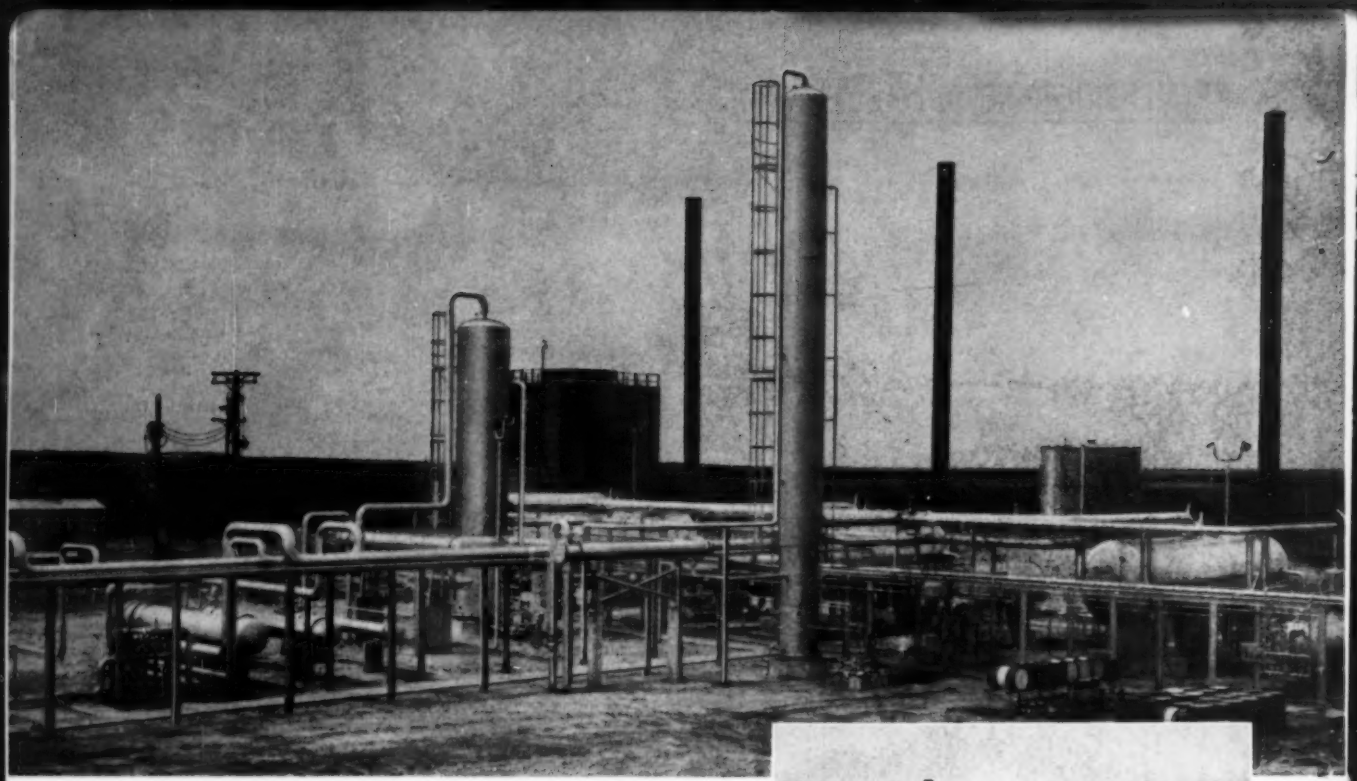
For detailed information or service call the Dowell station or office nearest you. Dowell has more than 165 service points in the United States, Canada, Venezuela, and Argentina. Dowell, Tulsa 1, Oklahoma.

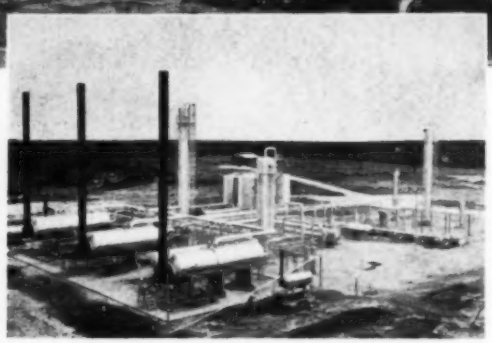
*Dowell Service Mark.

Services for the oil industry

DIVISION OF THE DOW CHEMICAL COMPANY

DOWELL





Split-Flow Design Desulfurization-Dehydration Plant . . . By BS&B!

From the very first moment the George H. Coates Desulfurization-Dehydration plant in Fashing Field, Atascosa County, Texas, went on stream, it has operated efficiently and well without the slightest difficulty or trouble. Desulfurization is accomplished by means of a monoethanol amine solution, and dehydration by a glycol solution.

Here are some points worth noting about the plant and its operation:

1. Incoming gas of 10% acid gas content is "purified" to sales gas containing only .25 grains of sulfur per 100 SCF.
2. Sales gas is dehydrated to pipeline specifications.
3. Volume of sales gas handled is 16.6 MMSCFD at 1100 psig.
4. Split-flow design greatly reduces fuel gas consumption.
5. This unit does *not* require the use of steam for heating.

If you have a "sour" gas problem on your lease, your BS&B Man will be glad to work out details with you for a similar installation tailored to your requirements. Why not call him today!

BS&B

ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

DEPT. 1-C9 P. O. BOX 1714, OKLAHOMA CITY

at Tidewater's Avon Refinery:

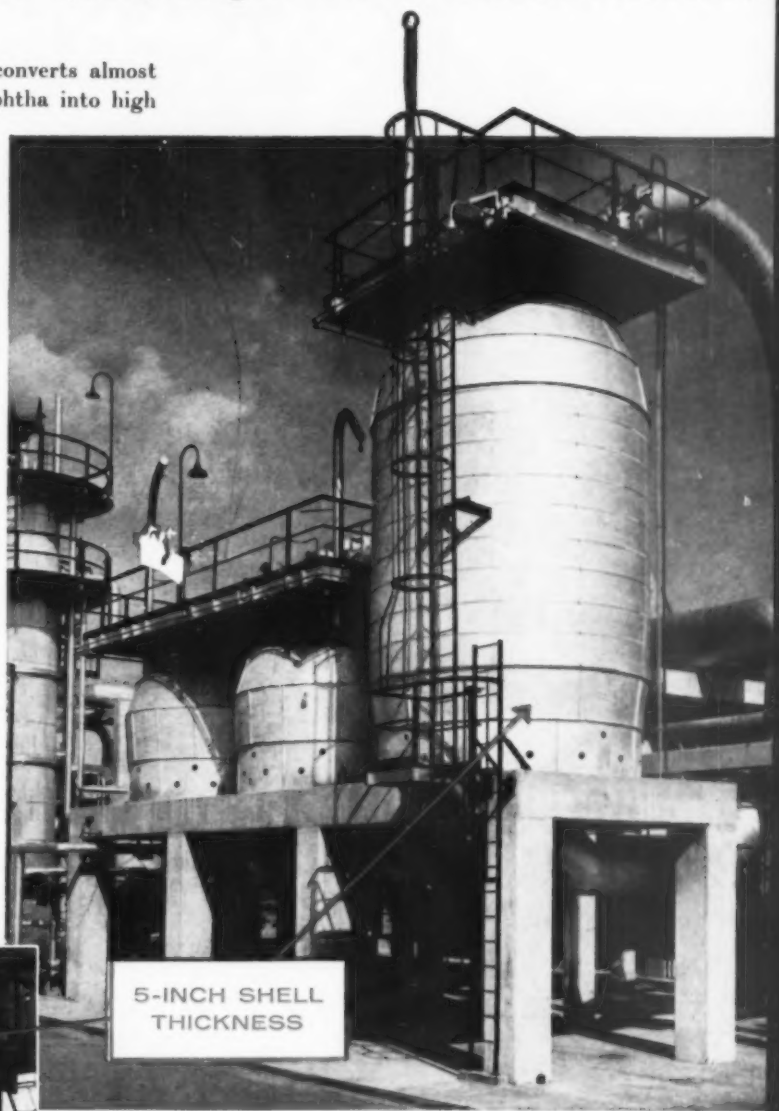
.....CB&I—built reactors serve 1,000,000-gal. HOUDRIFORMER Process...

This high severity catalytic reformer unit converts almost a million gallons per day of low octane naphtha into high octane blending stocks.

The three CB&I-built reactors incorporated in the process handle upwards of 127,000 pounds of platinum catalyst per charge. They were fabricated of plates up to 5 inches thick . . . to meet the rigid specifications dictated by extremely high and controlled temperature and pressure conditions. In addition, the critical vessels were shop X-rayed and stress relieved to insure optimum performance and long service life.

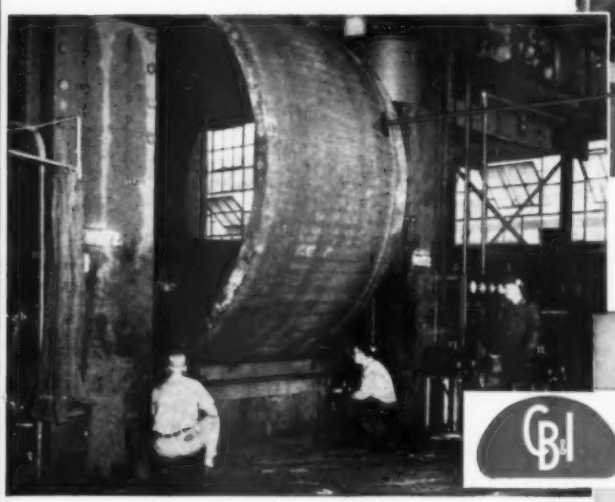
Fabricating 5-inch plate to customer or code specifications is not an unusual job for CB&I. Increased complexity in refining operations demands the exacting attention to detail made possible by CB&I's advanced metallurgical facilities.

Creative fabrication, combined with experienced and *coordinated* engineering and erection services is the reason leading processors rely on CB&I for the tanks, towers and processing vessels which help to keep them abreast of petroleum progress. Write our nearest office for the bulletin: *CB&I Creative Craftsmanship in Steel.*



CB&I-built reactors contain catalyst for *Houdriformer*—high severity reforming process. Hydrogen by-product, generated in process, is recovered for use in another process that removes nitrogen and sulfur compounds from gasoline and propane.

Reactors were furnished through the Bechtel Corporation.



Five-inch thick plate for walls of large reactor (shown above) was fabricated at CB&I Birmingham plant.

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Kansas City (Mo.)
New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • South Pasadena • Tulsa
Plants in Birmingham • Chicago • Salt Lake City • Greenville, Pa. • New Castle, Delaware

SUBSIDIARIES:
Horton Steel Works Limited, Toronto; Chicago Bridge & Iron Company Ltd., Caracas; Chicago Bridge Limited, London; Chicago Bridge Construcoes Ltda., Rio de Janeiro

REPRESENTATIVES AND LICENSEES:
Australia, Cuba, England, France, Germany, Italy, Japan, Netherlands, Scotland

F79-C

HOW TO CHECK OUT THE TOUGHEST TAPE EVER WRAPPED AROUND PIPELINE

Give it the works . . . that's what Polyken did to its latest development— Extra Strength No. 960

. . . Run it through every tape durability test a laboratory can apply.

. . . Wrap this rugged tape around 30 miles of 24-inch gas line in the swamp water and coral rock of southern Florida. Let an Iranian oil company use it on 200 miles of desert oil line. Put it to work for the Phillips Petroleum Co. in Texas and Canada.

If a tape coating can stand all this and still do the whole job cheaper than hot dope, you've got something special. Something permanent in pipeline protection—Polyken Extra Strength No. 960 Pipeline Roll.

Available at no extra cost.

Applying Polyken protection, as seen above, the Houston Texas Gas and Oil Corporation laid a 1600-mile gas line from Louisiana to Florida. Polyken saved them $500 per mile by way of less men per job and more miles per day. Tape's ready. No primer, no drying or cooling, no fumes or fire hazard. And *low* equipment cost.

Get the full particulars on Polyken performance and economy from your Polyken representative or write Polyken Sales Division, 309 W. Jackson Blvd., Chicago 6, Ill.

Polyken®

Experienced in modern PROTECTIVE COATINGS

THE KENDALL COMPANY
Polyken Sales Division

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

The Seats are the

W-K-M's NEW *Pressure Sealing* GATE VALVE

ASA 150 lb. (275 cwp)
and ASA 300 lb. (720 cwp)

Approved for many services including:

air • gas • water • butane/propane gasoline • kerosene • alipathic alcohols aliphatic hydrocarbons • animal and vegetable oils • crude oils • naphtha • glycerol ethylene glycol.

SECRET!

Line Pressure Seals the Seats

The seats – made of specially formulated rubber molded to a hardened steel insert – are the secret to the valve's tight sealing performance. As line pressure in the valve increases, these unique seats actually float with the pressure to seal tightest where the most pressure is exerted.

Important Safety Feature

Excessive body pressure caused by thermal expansion is automatically relieved. The upstream seat is forced away from the gate by the excess pressure, allowing it to bleed into the line.

Change Seats in Minutes—on the line

You can change seats in W-K-M's Pressure Sealing Gate Valve (2" through 12") in 15 to 30 minutes . . . *on the line.* The only tools needed are a wrench and a pair of pliers.

Full Bore, Through-Conduit

Full bore, through-conduit gate construction permits a smooth flow with no more turbulence or pressure drop than through an equal length of pipe. The seats are fully protected from abrasive action of the lading flow.

Available Now

This versatile valve is available at leading supply stores everywhere. It's designed for pressures up to 720 psi (cwp) and temperatures up to 250° F.

ANOTHER OUTSTANDING PRODUCT OF W-K-M's *Creative Engineering*

Write for Catalog 1200

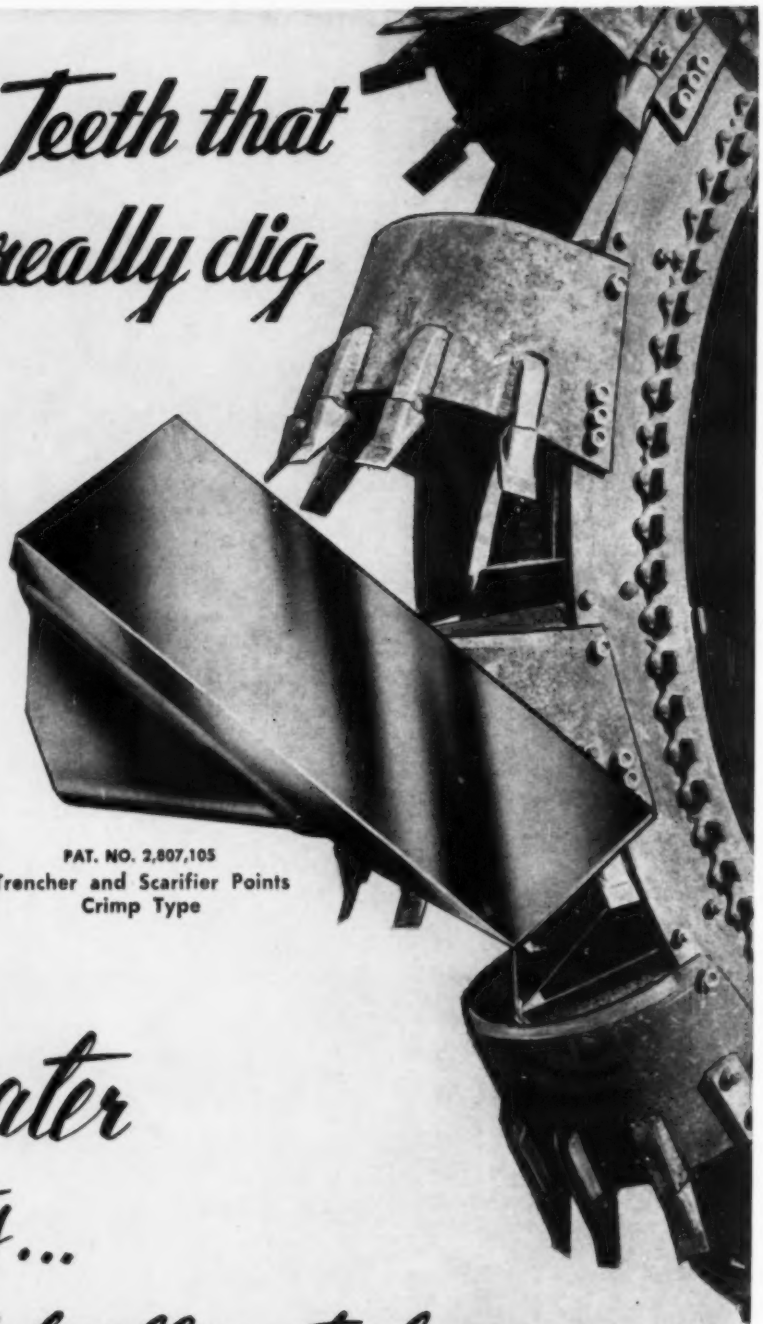
W-K-M Division of ACF Industries, Incorporated
P. O. Box 2117, Houston, Texas

W-K-M
SERVING INDUSTRY 40 YEARS

5909

H&L *Teeth that really dig*

H&L Alloy Steel Heat Treated Buckets–with Weld-on Center Shanks, and Bolt-On side cutters.
These trenchers are giving more ditch per hour in all types of material.



PAT. NO. 2,807,105
Trencher and Scarifier Points
Crimp Type

for Greater profits...
forged high alloy steel

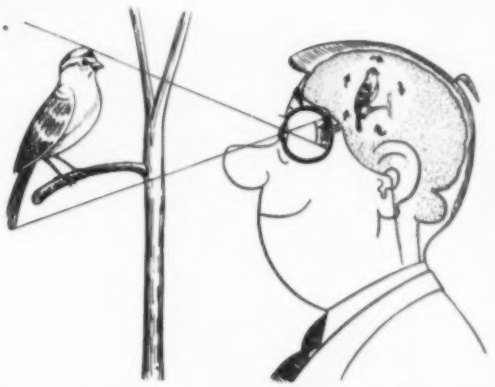
SEE YOUR H&L DEALER or write:

H&L TOOTH COMPANY
1540 SOUTH GREENWOOD AVE.
MONTEBELLO, CALIFORNIA

SPECIALIZING IN TWO PART TEETH FOR OVER 28 YEARS

Even if your job does not require the wearing of safety glasses or other protective equipment, there are a number of eye-care habits you should cultivate because . . .

Your Eyes — They're Wonderful



Like an extraordinary camera, your eye "receives" an image, focuses it onto the retina and "translates" it into meaning by the sight areas of the brain.

IF AN ORDER were placed for a miniature Cinemascope-3-D-color television unit, linked to a thinking machine with a lifetime supply of power, no scientists or engineer or inventor could design it.

But you, as part of the miracle of life, already possess such a mechanism in duplicate — your eyes.

And they seldom rest. Each year, for example, Americans read 18.5 billion newspapers, 4.5 billion magazines and more than 450,000,000 books. We watch 5 billion showings of movies, millions of hours of plays, and ever-rising multi-millions of hours of television, according to researchers for the Murine Company of Chicago, leading eye lotion producer.

More important, perhaps, your eyes are instrumental in your earning a livelihood, raising a family, or utilizing such modern institutions as the automobile, dial phone or supermarket.

The power of sight, as science can attest, is one of the matchless wonders of nature. Some 10 times a second — 36,000 times an hour — an image can be received by your eyes, interpreted in any of 150 colors, flashed to the brain, and made the basis of instant commands to any of a thousand muscles of the body.

Like a camera, the eye "photographs" through a lens. This one, however, is able to automatically change curvature in a split-second to focus images on a tiny "film" (the retina) no larger than a postage stamp. There, 137,000,000 light-sensitive cells photochemically change the image to nerve impulses, which flow through a million fibers of the optic nerve for "translation" in the sight areas of the brain.

Regulating the amount of light entering the eye, as would an automatic shutter, is the pupil, a black-appearing spot surrounded by colored pigment called the iris. Covering the front of the eye, as a crystal protects a watch face, is a transparent tissue, the cornea.

The eye, so precise in its workings it distinguishes points one ten-thousandth of an inch apart or follows a baseball approaching at 100 miles an hour, also has a movable shield (the eyelash), wiping mechanism (upper eyelid) and cleansing agent (tears). Though one eye is sufficient for full vision, Nature, foreseeing injuries or illness, has provided two orbs for "insurance."

Because the visual function is so closely related to others possessed by humans, if you're run down physically, your eyes can't do their work well. Also, if you abuse your eyes, other parts of the body join in a protest — causing headaches, indigestion, insomania, sour disposition or other unpleasantries associated with eyestrain.

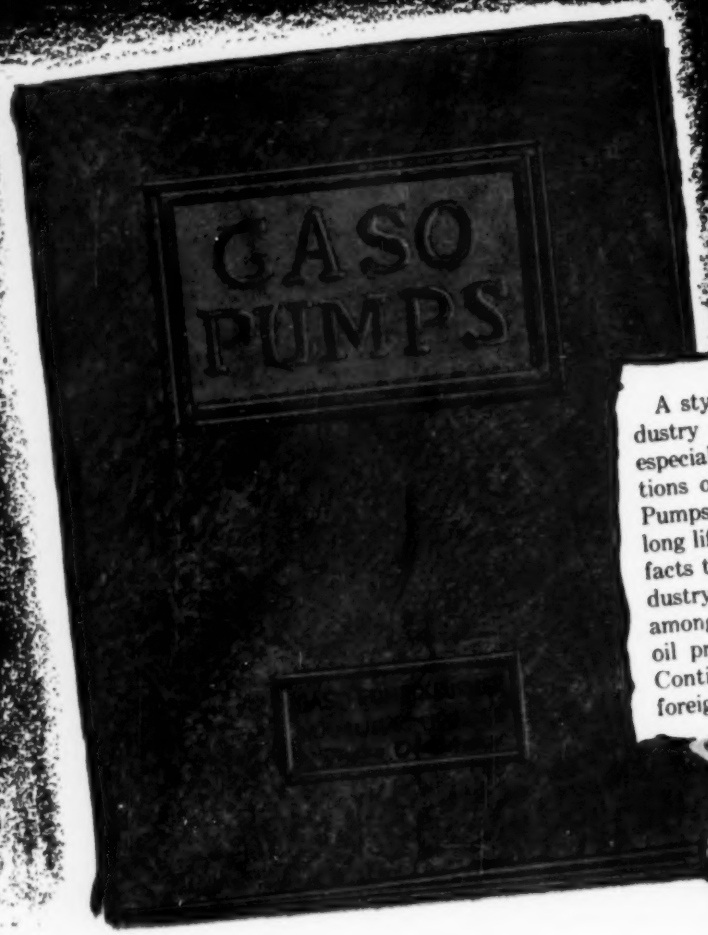
Thus, the requirements for keeping your eyes in good condition are these:

This article is reprinted from *Newsevent*, company magazine of The British-American Oil Producing Company, Andy Tarvin, editor.

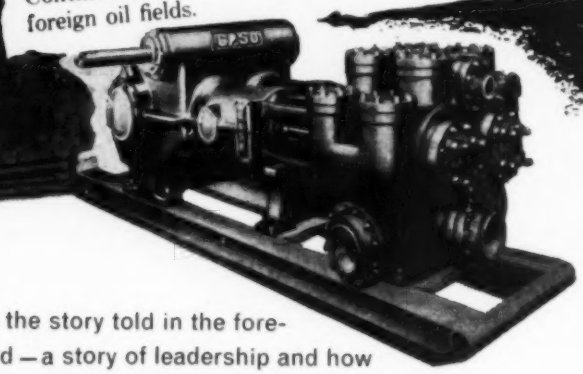
More than the stock market bounces up and down when your eyes follow "close work" on a moving vehicle. To read or knit on a bus may save time, but it's smarter to save your eyes from strain.

Movies, newspapers, books, magazines, television — your eyes carry a Herculean workload every waking moment. Resting your eyes at intervals helps to avoid over-working them.

PUBLISHED 34 YEARS AGO ..Still True



A style of pump is offered to meet every Oil Industry need, and every item in our line has been especially designed to withstand the severe conditions of oil field and refinery service. That Gaso Pumps have met the tests of unflinching operation, long life and low maintenance cost is attested by the facts that over 12,000 have been sold to the Oil Industry in the past ten years and that we number among our customers practically all of the leading oil producing and refining companies in the Mid-Continent, as well as many in other domestic and foreign oil fields.



It is a far cry from this catalog, published 34 years ago, to our latest catalog, recently released. Today's Gaso line includes models to meet every need and condition within the capacity range of the pumps. Today's Gaso Pumps embody metals and design principles unknown in 1925.

But the story told in the foreword — a story of leadership and how it is maintained — is as true today as when it was first presented, 34 years ago.

Have you a copy of our latest catalog? If not, we'll be happy to send you one.

DISTRIBUTORS:

Farmington, N. M.—Gaso Pump & Burner Mfg. Co.
Shreveport, La.—W. L. Somner Co.
Odessa, Texas—W. L. Somner Co.
Brookhaven, Miss.—W. L. Somner Co.
Tinsley, Miss.—W. L. Somner Co.
Hobbs, N. M.—W. L. Somner Co.
Houston, Texas—Texas Pump & Compressor Company
Wichita Falls, Texas—Pump Engineering Co.
Evansville, Indiana—Hague Equipment Co., Inc.
Long Beach, Calif.—Power Pumps, Inc.
Casper, Wyoming—Lufkin Foundry & Machine Co.
Edmonton, Alberta, Canada—Lufkin Machine Co., Ltd.

GASO PUMP & BURNER MFG. CO., 901 EAST FIRST ST., TULSA, OKLA.
EXPORT OFFICE: EMPIRE STATE BUILDING, NEW YORK, NEW YORK

GASO PUMPS
for every oil industry need

100th Anniversary of Oil in America 1959 **44th Anniversary of Gaso Leadership**

Follow the general ground rules for overall good health. That means adequate sleep, exercise and nutritious foods.

Observe special rules for eye hygiene. Don't permit unclean objects to come in contact with the eyes. Don't rub them with your hands. If there's any danger that chemicals, chips, dust or other material may get in your eyes — whether you're a factory worker, do-it-yourself craftsman or housewife — protect them with safety glasses. Don't let children play with potentially dangerous toys, or engage in rough, unsupervised play; three-fifth of all eye injuries in youth occur during such play, three times as often to boys as to girls.

Whether you think there's a special need or not, see an ophthalmologist at least once a year. Many eye diseases are serious only if not treated early. Also, eyes often reveal ailments elsewhere, including serious ones such as brain tumor, anemia, tuberculosis, jaundice and diabetes.

Be sure you work or read in adequate light. This means glare-free, shadowless light, from a source above or behind you, bright enough to illuminate what you're doing without causing squinting or undue fatigue. For reading, the light should be at least a 100-watt bulb, casting light over one shoulder without glare or shadows. "Pinpoint" or "spotlighting" is not recommended. The page should be some 18 inches from your eyes, in a near-upright position. In daylight, outdoors, it's best not to read in the sun; indoors, face away from rather than toward a window.

Don't indulge in excessive movie or TV-viewing. Movies, because their action takes place over a relatively wide area and requires the eyes to "exercise" while watching, aren't as fatiguing for the eyes as TV can be. With either, however, remember to rest the eyes by closing them occasionally.

When outdoors, protect your eyes from glare. Looking directly into bright sun for several moments is one of the few ways the eyes can be damaged in use. To reduce the effects of glare from sunlit snow, water or pavement, wear smoked glasses, a hat, and close the eyes to rest them frequently.

Don't perform "close work" while on vehicles in motion. Reading or knitting on a bus or train may appear to save time, but it can contribute to eyestrain. The movement of a vehicle on even the smoothest of surfaces causes a certain amount of eyeball vibration.

Follow these rules and you will probably find that those wondrous windows to the world — your eyes — will be good and faithful servants for a lifetime. ★ ★ ★

Why Not Guarantee Your Investment?

A United States Government guarantee is available for new investment in friendly foreign countries for a small charge

AN AMERICAN BUSINESSMAN who may be making new investments abroad can apply to the U. S. Government for guaranties against the risk of:

1. Inconvertibility of currencies
2. Loss through exploration or confiscation
3. Loss from damage to physical assets caused by war.

The program is administered by the International Cooperation Administration and is designed to encourage private U. S. investments in friendly foreign countries.

The guaranty program is the result of legislation passed to encourage and facilitate participation by private enterprise expanding and developing existing enterprises or in setting up a new business in foregin countries.

Total number of countries now covered is 42. This includes two new ones which have been added lately — Tunisia and Sudan, in Africa.

Since further agreements are in continual negotiation, if an investment is contemplated in an area not listed it may be advisable to check with the Investment Guaranties Division to ascertain if an agreement is being considered.

The government does not offer guaranties against failure to make a profit, general devaluation of a foreign currency, inability or failure of a borrower to repay due to a decline in his assets, or against other normal business risks that attend any investment. But it does, subject to the conditions stated below, offer a practical means of insuring against three of the chief dangers listed above which have troubled prospective American investors abroad in the past.

The cost is generally one-half of 1 percent per year of the guaranty coverage for each type of guaranty and is available for periods up to 20 years. Investments may be cash, equipment or material, patents, processes and techniques, and may be in the form of equities, loans or licensing agreements.

To be eligible for guaranties an investment must be by a United States citizen or United States companies; majority-owned by U. S. citizens. It must be for a minimum of three years if a loan or for five years if an equity investment or a licensing arrangement.

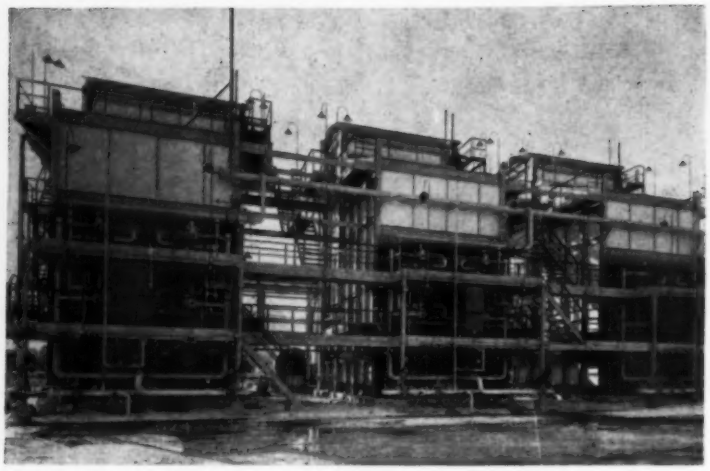
The first thing to do is to write Investment Guaranties Staff, International Cooperation Administration, Washington 25, D. C., and request the Investment Guaranty Handbook. This will give you the procedure for your application and explain the nature of protection the government undertakes.

As we pointed out, this is not a free service but for each guaranty the expropriation and the convertibility the company pays annually one-half of 1 percent of the face amount of the contract. Fee for a war risk guaranty is one-half of 1 percent per year of the dollar amount of protection during the first 10 contract years. After that it is subject to adjustment in light of experience, but may not exceed 4 percent per annum. All fees are payable in advance and are due yearly on the anniversary date of the contract.

The President is authorized to issue guaranties up to a total of face value of $500 million. So far under $200 million of guaranties are outstanding.

OIL AND OIL SUPPLY COMPANIES WITHIN U.S. GUARANTIES

Country	Investor	Product	Convertibility	Expropriation
AUSTRIA	Socony-Mobil Oil Co., Inc.	Oil distribution	$ 1,000,000	$1,000,000
FRANCE	Houdry Process Corp.	Petroleum Refg.	202,000	—
	Standard Oil Development	Oil refinery	550,000	—
	Standard Oil Development	Oil refinery	504,000	—
ITALY	Caltex Oil Products Co.	Oil refinery	4,630,000	—
	Houdry Process Corp.	Petroleum Refg.	75,000	—
	Socony-Mobil Oil Co., Inc.	Oil refinery	5,600,000	2,800,000
	Socony-Mobil Oil Co., Inc.	Cracking unit	7,234,000	3,617,000
	Standard Oil Co. (N. J.)	Oil refinery	14,487,500	—
JORDAN	Edwin W. Pauley & Phillips Petroleum Co.	Oil exploration	—	6,000,000
	Robert L. Parker	Exploration equip.	—	1,250,000
PARAGUAY	Pure Oil Co. of Paraguay	Exploration and exploitation	—	3,000,000
UNITED KINGDOM	Drilling & Exploration Co.	Drilling	420,000	—
	Universal Oil Products	Catalysts	750,000	—



AT LEFT: Installing a 60,000 lbs/hr unit in a brewery

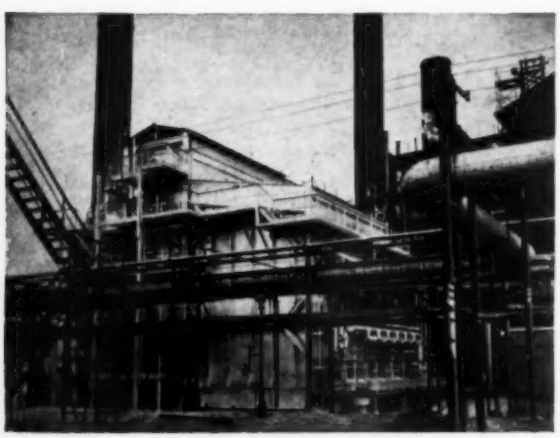
ABOVE: A battery of 125,000 lbs/hr units in a chemical plant

CUSTOM *Steam* GENERATORS by Vogt

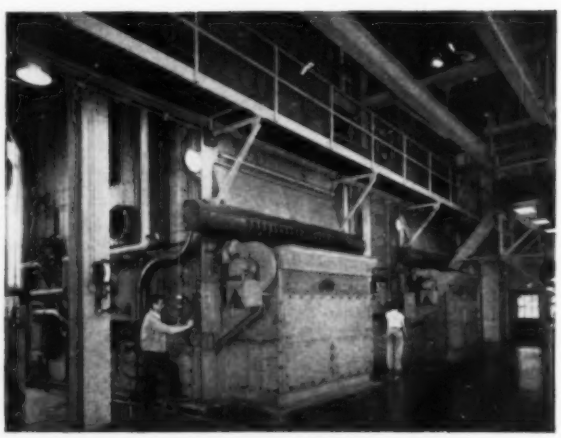
Vogt engineering advances can save you money if you have a steam generating problem. Custom-built installations shown, are engineered to assure efficient, dependable steam generation for power, process and heating. Our engineering staff is available to give effective help in the solution of steam generating problems peculiar to a wide variety of operating conditions. Address Dept. 24A-BPR.

HENRY VOGT MACHINE CO.
LOUISVILLE, KENTUCKY

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati



This 400,000 lbs/hr unit is installed in a leading petroleum refinery



Three 40,000 lbs/hr units serve a medical center

PAPERWORK PROGRAM begins with Training Conference. At this meeting to launch the simplification course are Jack Ligon, John Bengel, Bill Johnson, Frank Blyth, Jack Jackman, Dave Kauffman, J. L. Byington, Clarence Pugh, Bill Tucker, Walt Harvey, Charles Campbell, John Reidy, Louis Cole, Kenneth Hull, and Milton Marshall.

Weigh Your Paperwork

Sometimes you can see results of simpler paperwork in dollars . . . Other times you can only see a quicker, smoother job that gives the worker cause for pride . . . Sinclair Pipe Line people use their own simplification program to good effect and here they tell you how they manage it . . .

F. X. Wernett and L. E. Salisbury

SEVERAL YEARS AGO the management of Sinclair Pipe Line Company asked itself this question: Since paperwork by itself is costly and usually non-productive (therefore non-profitable) isn't it ridiculous to tolerate more than is necessary?

DID YOU KNOW the average business man *wastes* 65 cents of every dollar he spends for paperwork, and for every 87 cents he saves in *checking* paperwork he spends $1.25?

DO YOU KNOW it costs $6200 to create and file the contents of an average four-drawer file?

DO YOU REALIZE $108 billion is spent in this country each year to create records alone?

AND LISTEN TO THIS: For each $100 saved in operating and overhead costs, the average business man can save more effort than is required to produce $4000 in sales.

Startling as they seem, these statements are supported by scientific research. Few persons today have any idea of the magnitude of the paperwork problem in this country.

Movement of supervisory personnel from one business to another, taking past methods with them, and the interchange of opinions and ideas among business acquaintances have tended to increase the mass and complexity of business procedures. This makes it difficult to separate necessary from unnecessary paperwork.

Because of increased capacity, and expensive rental and purchase costs of modern electronic machines, business firms sometimes justify use of these marvels by creating large amounts of paperwork (which are hardly essential). Use of the term "electronic", sometimes gives increased business stature, but use of the machines can just as well be the origin of tremendous amounts of waste.

Many management people think of paperwork as being productive to some degree (or being a necessary evil) and let it go at that. Except for banking or insurance firms there are few, if any, businesses that actually find paperwork productive. This is not to say that all paperwork is unnecessary; some of it is needed.

There seem to be as many opinions of what is, and what is not, necessary as there are businesses. The most accepted definition of essential paperwork includes only two possibilities:

1. Paperwork due to circumstances beyond company control. Municipal, state and federal agencies, etc., require certain information kept if the company is permitted to conduct its business.

2. Paperwork that helps people do *worth-while jobs*. If the job itself is not necessary, neither is the paperwork produced by that job.

Some people think of "Paperwork Simplification" as a process of breaking down paperwork into simple jobs requiring less-skilled personnel.

This is not the goal of such a program at all. Paperwork Simplification

PAPERWORK SIMPLIFICATION PROGRAM

A. NEED MANAGEMENT SUPPORT

B. HOLD CONFERENCES — (meets Monday through Friday afternoons — total 20 hours)
   1. Letter from president
   2. Handbook
   3. Props
   4. Problems
   5. Charts
      a. Flow process charts
      b. Procedure flow charts
   6. Analysis and evaluation
   7. Recommendations
   8. Submit new problems
   9. Study team named for each problem (meets 1 hour a week)
   10. Prepare report
      a. State problems
      b. Make recommendations
      c. Give possible results

C. GIVE INFORMATION on actual results to conferees.

is to the office what Work Simplification is to the factory. It is a philosophy that embraces a general systematic conservation program relating to paperwork in all its ramifications.

Its goal is to save time, energy, space, everything possible.

It recognizes the human element as the most important factor in its success. Where Paperwork Simplification programs have been successful, both employees and employers have benefited.

To measure and combat waste in paperwork at Sinclair Pipe Line Company a Paperwork Simplification program was initiated by Ben S. Graham* about five years ago. The program is now conducted by company personnel, and the training of Sinclair people will continue on a voluntary basis until all who are interested have had an opportunity to study the subject.

Backed by Management

A program of this type, if it is to be sustained, must have not only approval but enthusiastic support of the entire management group. Each conference is opened by a representative of management stating the company's interest and objectives. In an introductory letter E. W. Unruh, president of Sinclair Pipe Line Company, describes the theme of the conference when he says, "All of us have a big personal stake in Paperwork Simplification . . ." ". . . By active participation in this program you will be helping to simplify and improve your work and the work of others, and increase your overall knowledge."

After introductory remarks each participant is called upon to describe briefly the work he does. This helps to encourage participation from the beginning and the conferees are urged to express freely their thinking throughout the course.

*Ben S. Graham is director of Methods Research of Standard Register Company, Dayton, Ohio.

First a Conference

Stationery, material and "props" are assembled to present the subject. A manual entitled "Greater Job Satisfaction Through Paperwork Simplification" has been printed in the company print shop to orient the individual regarding the importance of participation and the use of the scientific method of problem-solving. Most techniques in training, with which we are familiar, present the philosophy in a general way; however, we are using specific problems to train personnel. This involves the use of problems peculiar to the pipeline business.

The conferences are scheduled to last a maximum of 20 hours. Attendance is confined to afternoons only, Monday through Friday. This method permits the conferee to attend to his regular duties.

Program Tightly Scheduled

With such limited time a course must be highly intensified. It involves careful planning to give participants a balanced grasp of the subject. Enough time is allowed to permit individual approaches but the tempo is kept moving at a brisk steady pace. There is no time for rambling or straying from the subject.

Scheduling is a big problem in order to avoid hurried and abrupt changes during the progress of the conference.

Participation Encouraged

Interest is enhanced as employees become convinced that they, as well as the company, will benefit from the saving of effort and the elimination of boring tasks where possible. Participation becomes keen during the demonstration of work simplification principles by the use of "props."

Productive operations become distinguishable from non-productive ones. A simple peg-board problem dramatizes and creates lasting impressions of improvements and savings of effort through the application of know-how, smooth flow and simplifying processes. During the conference competition is limited, much like a golf game, to each individual's self-improvement.

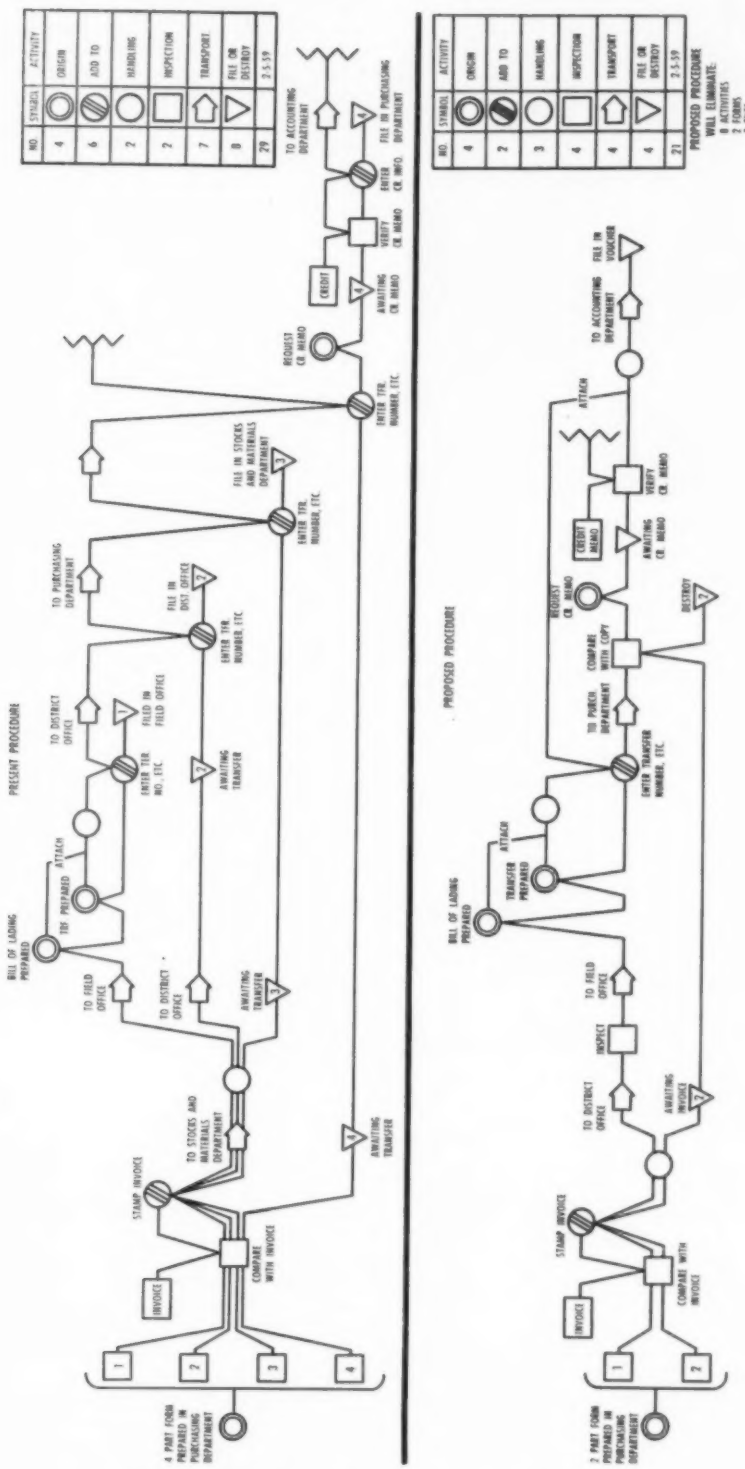
Close as the subject of paperwork is to office personnel most of the participants fail to grasp the full importance of the conference at the beginning. This is a natural reaction and should not cause concern during the introductory period. However, by the time problem solving begins with a selected example all are quite aware of the goals. After the selected problem has been defined the gathering of all facts and the orderly presentation of a procedure through the use of charts is carefully discussed.

The Authors

F. X. Wernett is manager of Methods and Procedures Department, Sinclair Pipe Line Company, Independence, Kansas. A native of Pennsylvania, he attended Rensselaer Polytechnic Institute, Troy, New York. Prior to affiliation with Sinclair, he was assistant chief accountant and later auditor of Revenue for Pennsylvania Turnpike Commission, Harrisburg, Pennsylvania. He is a member of Systems and Procedures Association.

L. E. Salisbury is assistant manager, Methods and Procedures Department, Sinclair Pipe Line Company, Independence, Kansas. He is instructor in work simplification program. A native of Kansas, he attended Kansas State College of Pittsburg, Kansas, and has had 30 years' service with Sinclair Organizations, 10 of which were spent in machine accounting field. He is a member of Systems and Procedures Association, Tulsa Chapter.

FIG. 1. Container Notice Procedure Flow Charts.



Charts should be kept simple so they can be easily read. Process charts are later welded into procedure flow charts. Note how procedure here has been simplified in the proposed flow chart at right.

Charts Prepared

Methods in charting, like literary composition, may vary somewhat, depending upon the person preparing them. To be effective charts must be simple and easily understood by anyone who may use them. Actual charts of the processes involved in the selected problem are prepared by each participant. Some of these processes are drawn during the assembly, while others are assigned for individual study to be presented at the following day's meeting.

This individual study permits a wide latitude of expression since outside influence is not present. The assignment is discussed at the next meeting until all are satisfied with the methods used.

Attention is then turned to the welding of processes into a procedure flow chart of the present method. It is here explained that, due to complexities frequently encountered, procedure flow charts are usually prepared by procedure analysts. Since it is desirable that each participant be able to understand procedure flow charts, however, methods of preparation of these charts are taught.

Each participant is urged to complete a procedure chart based on the process charts he has prepared. Examination of the procedure flow charts is held the following day. At this time much spontaneous discussion develops. Most individuals are alert and express ideas freely. Few persons who participate in these conferences will experience difficulty in preparing flow process charts and reading procedure flow charts.

Evaluation Made

After the present method is charted analysis and evaluation of the charts begin. The five questions:

What?
When?
Where?
Who?
How?

are asked of each step in the process. Each of the five answers are questioned with the word:

Why?

If any of these answers cannot be justified, appropriate action is noted. Now the proposed method is developed from the answers gained in the analytical and evaluating processes. Proposed flow process and procedure flow charts are prepared for inclusion with recommendations to be presented to management.

Don't ever forget the contribution employees make to the program. Give full credit. Participation with know-how probably accounts for more than

IN STUDY GROUPS particular problems are analyzed. The four in this one are Kenneth Winkler, Bob Waggoner, Earl Burnworth and Bob McHenry, all with Sinclair. This group will state problem, give recommendation, and predict possible results.

75 percent of the success of the program.

Another point to remember — a very poor procedure will make a good showing if the people who use it want to make it work. A good procedure isn't worth the paper it is written on if the people who use it are indifferent or want to sabotage it. If an employee has a part in developing a procedure, and is enthusiastic about it, he will want to make it work. It's his idea and he has a stake in its success.

Invite Suggestions

Near the close of each conference the participants are asked to submit problems involving company procedures which they feel could be improved. Proposed problems are usually related to work performed by the participants. This is not a requirement, however, if the problem is offered in good faith.

The conferees are asked to select four or five of the most promising problems and to align themselves into study groups according to their choice of subject. All remaining suggestions are reserved for future study. At least one person in each group must be familiar with details of the problem.

Don't forget, though, where there is a will to improve, a participant can furnish constructive aid even though he may not possess intimate knowledge of details involved. In fact it is desirable to have one or more people on a study team who are not familiar with all details. Their lack of close association will often furnish fresh perspectives.

Study Teams

Group membership is limited to four or five persons. Meetings arranged for study are not to exceed one hour per week. To avoid misunderstandings all who are affected or concerned with a study are kept fully informed.

Each conferee has an opportunity to put the theory he has learned into actual practice and thus increase his knowledge through experience.

How to Make Reports

Reports to management include: (1) Brief statements on the problems; (2) recommendations, and (3) anticipated savings where possible.

Projected savings in dollars make very fine selling points and certainly should be included in proposals whenever possible but many savings cannot be expressed in this manner. Secondary procedural and intangible benefits sometimes exceed these benefits resulting directly from the original study.

Results obtained by the company through application of Paperwork Simplification principles are discussed with the conferees. "Before and after" forms designs are displayed.

Form Design Improved

A good example of improved forms design is the form used to account for the movement of equipment and materials. As late as 1955 a five-(or more) part form was in use. Only about one-fourth of the total area of this form was used to record detail information regarding the movement of articles or materials. Removal and insertion of carbon paper was necessary at two different stages of the procedure. A matching operation in the general office of two parts of the transfer form resulted in some delay. Original and one copy were filed in expensive transfer cases in the general office.

The new form that resulted from the study is a three-part carbon-set design. Two-thirds of the total area of this form is now used to record detail information regarding the movement of articles or materials. No copies are required in the general office and the original transfer forms are filed in inexpensive pressboard binders.

This new form costs very little more than the old one and actual savings in the overall handling and processing procedure are substantial. Intangible savings far exceed those measurable in dollars and cents. Questioned about the use of the new form affected personnel gave such answers as:

"Cut our processing time by one-third to one-half."

"So much easier to process and reduced our error problem considerably."

"Much easier to prepare and follow."

"Saves lots of time."

"Field men are enthusiastic about the new transfer."

An improvement of this type needs no further attention to continue the same savings in the future.

After much research one authority concluded the average employee produces at the rate of 35 to 40 percent of his total capacity. His work is often routine and uninspiring. Sometimes it is downright boring, and more people die from boredom than overwork.

Interest and boredom can not exist together. If an employee is interested in his job, or accepts the challenge to improve it, he is happier and will increase production without pressure.

The whole program is a continuing one in which personnel trained by this program participate on a voluntary basis from time to time. Results of Paperwork Simplification have earned the program a promising future. We have found no sounder way to eliminate waste.

Paperwork Simplification is a part of a larger picture because it invites and enables employees to contribute to more profitable management of their companies.

The improvements of yesterday are the procedures of today, and today is tomorrow's yesterday. ★ ★ ★

HOW TO BE A MANAGER

Do On-The-Job Training

Lincoln Atkiss

"Know thyself." — Socrates.

"WHAT I WANT out of my job is more challenge." "I need more money." "My ego needs the satisfaction of more prestige."

And so it goes! The motivations are varied and mixed but most management members seek growth. How to obtain the growth required is often an elusive, evanescent problem.

Our approach in the evaluation of management members is aimed primarily at the identification of each man's specific development needs. The needs may include areas for improvement in present job performance or for growth to a higher assignment.

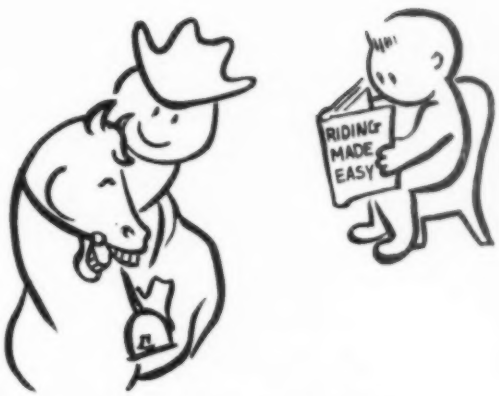
One striking thing about this work is that 90 percent of the needs for improvement can be met only by on-the-job training or experience.

A second patent fact is that there are very few common patterns of development requirements.

Each case is different and the differences are related to many circumstances, including the range and kind of education, work history, work habits, attitudes, skills, and personal adjustment to the competitive industrial scene.

Each man in this sense is unique and this is the reason management development cannot be thought of in the abstract. It cannot be generalized. It must be "particularized" in terms of the unique individual.

It follows, if we wish to develop ourselves as managers, we need to direct our thinking toward realistic objectives, objectives that are real for us. Otherwise, our efforts may be diffuse, academic and unprofitable. The best way we can be certain we are on the right track is to have the benefit of a thorough-going evaluation of our managerial capacity in terms of how we perform our present job and project these findings to how we might perform the next higher level job.



Best training is in-the-saddle training.

Lincoln Atkiss, *The Atlantic Refining Company's Director of Executive and Supervisory Personnel Inventory, is responsible for developing and coordinating company-wide appraisal work covering over 1000 management members. One of the major objectives of this program is to identify development needs and form a basis for development planning.*

A native of Philadelphia, Mr. Atkiss received his bachelor's degree from Swarthmore College and his master's degree from the University of Pennsylvania. He has done additional graduate work in educational psychology. A professional educator for 12 years, he has served as teacher, coach and administrator. During his 14 years with Atlantic, he has progressed through the positions of administrative assistant and director of training.

APPRAISE ACTION NOT QUALITIES

There are probably as many management appraisal systems as there are companies engaged in management appraisal. The best thinking in the field, however, has led to abandoning the trait-rating approach wherein judgments are obtained concerning whether the manager conforms to the Boy Scout oath: Is he "trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, reverent." Such generalizations are meaningless for development planning.

Instead, competent observers comment on how the manager performs each one of the key duties for which he is held accountable. Where evidence is found indicating a need for improvement the area is analyzed to determine what knowledge, skills and attitudes need strengthening.

For instance, a staff engineering manager whose group services five departments is found to be technically very able in essentially all areas of accountability except one: The departments serviced too frequently resist his group's proposals and some excellent technical ideas have died aborning.

Analysis of this area of deficiency discloses that the manager has a poor staff attitude; he feels the fine technical proposals should sell themselves; he lacks skill in selling ideas and has not developed his relationships for good team play with the departments. Instead, he visualizes his group as a technical aristocracy on which field managers should lean for technical direction. Development objectives rooted in job performance are now realistically isolated:

1. *Through coaching he needs a clarification of the staff function;*
2. *He needs to get into the field more and develop a personal relationship with each manager that will lead to more field participation in the development of recommendations;*
3. *He needs to improve his contact skill and develop skill in selling ideas.*

This is the kind of meaningful finding that can come from a company appraisal plan. The manager then, through performance review with his boss, reaches agreement on the area needing improvement and together they plan to achieve improvement by such means as on-the-job counselling and coaching, scheduling related activity, and utilizing selected company and outside training facilities.

After an interval the boss re-observes performance in the critical area to give the manager assurances concerning progress or to reach agreement on additional development approaches to gain the result desired.

TAKE INVENTORY

If our company does not have an appraisal plan that will help us identify our needs for growth, we can institute our own personal appraisal plan. It can be as simple as taking our duty list and asking our boss and other observers to comment on our effectiveness in each duty.

This takes courage but most bosses, if solicited, will jump at the chance to discuss with their men the strengths and weaknesses they see in their performance and make suggestions on how the strengths can be used to greater advantage and what might be done to overcome the weaknesses. Without a formal plan or a self-generated plan he is more likely to accept the strengths and work around the weaknesses with the result that growth of subordinates is coincidental rather than planned.

By such a self-generated inventory of performance, many development needs will be highlighted. You have been aware of many of these but never fully accepted them as objectives. Others will be news to you.

You then must cast aside the normal tendency to rationalize the needs and must face up to what to do about them. As noted, the great bulk of development can be obtained by critically controlling your actions on the job. Some of the needs will involve very specific skills. Others will involve less tangible attitudes.

Let's look at a few of the possibilities.

Suppose as an example of a specific need you discover that you are considered a good doer but a weak delegator. You can make a high resolve to delegate more but such generalized hopes of "turning over a new leaf" are usually fruitless. *You need a control.*

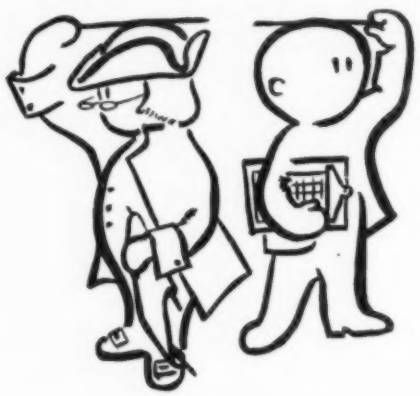
Don't carry the whole load yourself.

Try keeping a record of how you spend your time on the job for one month. Then analyze the record, preferably with your boss, to determine what things you are doing that should be done instead by subordinates, staff groups or others. This can prove an eye-opener and lead to much more intelligent application of delegation skill. It often discloses a tendency to hold on to activity that gave us satisfaction and security in previous jobs but is no longer a proper activity in our present job.

The inventory will disclose, inevitably, less tangible but very real development needs that fall in the area of personality. Too often all of us throw up our hands and say, "Ah, nothing can be done about personality, you just have to live with it." There is some truth in this attitude, for many facets of personality are not susceptible to change. However, many can be modified sufficiently for greater acceptance in job relationships if it is important enough to the individual to seek change.

Such modifications to achieve greater smoothness in human relationships are often vital to continued job success and future growth. Unfavorable personality factors too often disqualify a man in competition for advancement. What can be done about it?

One of the greatest men that ever lived, Benjamin



Measure yourself. Ben Franklin did.

Franklin, faced the same problem. He analyzed his limited acceptance by his associates and found weaknesses he wanted to correct as well as strengths he wished to acquire. He did something definite and positive about it with the result that both he and our country reaped a great harvest.

CHARACTER DEVELOPER

According to Franklin in his autobiography he had been conscious of his deficiencies a long time, but made such little progress in improving them that he was almost ready to give up when he arrived at a plan that changed his life — and this is what he did. He prepared a list of the traits he wanted to acquire. He knew if he tried to improve himself in all of them at one time he would accomplish nothing; so he decided to work on one problem at a time. He took, for instance, the characteristic of being too argumentative. He kept a close check on himself every day for a week. Had he restrained his debating that day or had he found the argument irresistable? He prepared a schedule that looked something like the chart shown here.

Across the top he had the days of the week, and along the side he listed the character trait he was working on. At the end of each day he would recall all the contacts he had with people during that day and would examine each to see how well he had controlled his tendency to argue. If he had failed, he would put a black dot against himself

BEN FRANKLIN SELF IMPROVEMENT SYSTEM

Characteristics	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.

Read how Ben Franklin used this.

under that day, or he would put a black dot for each failure if it had occurred more than once.

At the beginning of the following week he went to work on a different problem, keeping the same careful check on himself and making a concerted effort to have no black marks against himself. He continued this over a period of three months, working on a different personality factor each week. At the end of the three months he started at the head of the list once again, and as he obtained mastery over one he dropped it from his list; substituted a new one.

Ben Franklin **MADE** his personality what he wanted it to be. Of course, he didn't accomplish it over-night — neither can we. He concentrated on it over a period of years. He struggled with himself. He learned by that struggle.

This is a powerful plan that may make it possible for any of us to improve. It takes patience and a high degree of sensible self-criticism. Simple! Elementary! It was good enough for Ben Franklin. It's good enough for us.

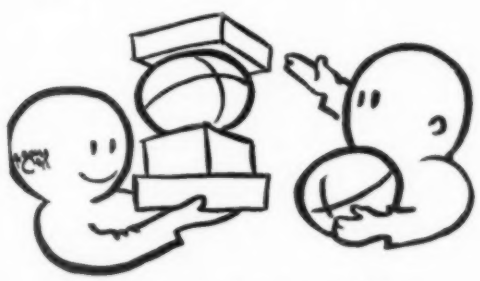
DON'T WAIT FOR THE KNOCK

Another type of general need is the need for broadened experience or for more challenge in our present job.

In business we can do much to create our own opportunities for this kind of growth and may have to, if we have a boss who is not aware of his duty to create opportunities for us. Now, how can we do this? Many bosses keep themselves overloaded and resent doing so, but will do nothing about it. If we are alert and really interested in growth we can watch our chance and as the boss grouses about some work he is doing, we can request that it be delegated to us. The boss is generally delighted to find somebody so willing to help and usually will unburden himself.

The same is true of committees. How often do we hear the boss talk about having to attend too many committee meetings? An analysis will show that many of these committee assignments can be delegated. We can propose we serve *for* the boss or at least perform as his alternate.

Most important of all, in every business situation there is a multitude of unsolved problems or solved problems that need re-examination. This can prove a happy hunting ground for any of us interested in self-development. There is no law against independent study and presenting proposals.



Offer to take on a piece of responsibility.

Interestingly enough in this respect, one of the key points in appraisal work is often the question, "What proposals has this man made recently?" It is amazing how infrequently there is a positive response to this standard.

Development for higher management assignments is commonly frustrated by specialization. Too often we yield to the exigencies of business and remain in a single line of activity so that we evolve as specialists who lack the flexibility to think in broad patterns. Specialization is a burial ground for the potential executive.

But many of our best executives have resisted this man-trap. They have persistently sought in their early careers, a variety of positions to give them the necessary flexibility and broad view. They have sought and accepted lateral transfers.

They have created their own rotational program and it has paid off.

Personnel Sections are eager to know the ambitions of employees. The able young management member interested in growth will make his wishes known and sell himself into this kind of opportunity. He takes a chance but the chance, given a basically capable man, generally has a big payoff.

We have discussed only a few representative actions that can be a part of a program for managerial growth. They are intended to point the way to growth through appraisal based on performance in specific duties. An attack on the findings of the appraisal must be backed with strong desire for growth and, although a boss can be of much help in guidance and making opportunities available, the development that takes place will always be fundamentally self-development.

Self-Searching Questions

1. What is the best basis for designing an individual development plan?
2. To what extent can you change personality defects?
3. To what extent is trait rating useful in discovering development needs?
4. How should a boss utilize the findings of an appraisal?
5. How can you develop your own appraisal?
6. What is our normal first reaction to appraisal findings?
7. How can you check on your effectiveness in delegating?
8. What is one approach to the correction of personality defects?
9. How can we create our own opportunities for growth?
10. To what extent can a boss contribute to your growth?

Reading References

[1] *Carl Heyel, Appraising Executive Performance, American Management Association, 1958.*

[2] *What Makes an Executive Round Table, Columbia University Press, New York, 1955.*

[3] *Chris Argyris, Executive Leadership, Harper & Bros., New York, 1953.*

[4] *A. W. Gouldner, Studies in Leadership, Harper & Bros., New York, 1950.*

[5] *Peter F. Drucker, The Practice of Management, Harper & Bros., New York, 1954.*

[6] *J. L. Mursell, How to Make and Break Habits, Lippincott, New York, 1953.*

[7] *Nathaniel Cantor, The Learning Process for Managers, Harper & Bros., New York, 1958.*

[8] *Auren Uris, The Effective Executive, McGraw-Hill, New York, 1957.*

★ ★ ★

Dr. Ottillinger meets the Los Angeles press. She recounts her eight years as prisoner of the Russians. Says she, "The good advancement of Communists in all countries is only because the other side is so fearing."

Austrian OMVAG Struggles With Reds

An interview with Dr. Margarethe Ottillinger, Vice President, Österreichischen Mineralölverwaltung A.G.

Ernestine Adams

Q. *When the Russians returned the petroleum industry to Austria, did you have any more trouble with them, Dr. Ottillinger?*

A. When the Communists were forced to leave Austria after the Armistice that left our country to govern itself, they planted people in business and industry so that they could harvest a crop of economic chaos.

Because the oil industry is always a very important point in an economy they had assigned in our company (OMVAG) all Communists which were possible to get in this company. Who has the oil industry in his hands he can always trouble an economy. He can always make something what isn't right.

So, after the Russians went out we had an election.

Q. *What kind of election do you mean? A union election?*

A. For the leaders of the workers. Yes. For example, you have a company with many hundred people—they are electing their leaders, which speak with the leaders of the company about all worker problems. And for this election the Communists were well prepared. We have papers on which is written what you are electing.

Q. *A ballot?*

A. Yes. After the election these ballots were put in a table drawer during the night. A Communist woman secretary slipped into the room, took out all these papers and put in only ballots on which Communists had voted for their candidates.

Now, as the election ended, everybody was astonished that now after the Russians were gone so many people are for Communists — you see? The others were already suspicious—what was this? So they went to the court, but it wasn't possible to prove anything and so the court said there is nothing to be done — everything is all right. They couldn't prove that something was wrong in this election even though they were strongly suspecting.

But when the next election came, the secretary—this woman—she was afraid. They said to her—the leader said to her—"You must make it in the same way." But she was already afraid to do it and she told this to a Socialist leader of the workers. They go to the court then and declare something was wrong with the first election. At the end of this court case, the decision was that the election wasn't right.

Q. What did this problem have to do with you?

A. I had in my hands the management of all employee relations, and everybody in the company was looking at me. What now is beginning? This is such a severe test. They were asking each other, "What will she do? Will she do something against the Communists or not because now it was proved that they had done wrong, and three of the most important leaders of the Communists in our company were guilty. And I had the possibility to release them—to move them out from the company. Now everybody knows that the Communists in the company will not bear it, you see. The whole company divided into two parts. One

Miss Adams is Management Editor.

WHEN DR. MARGARETHE OTTILLINGER, one of four managing directors of OMVAG, the Austrian government-owned oil company, visited the United States in 1958, we interviewed her at length about the petroleum industry in her country which she helps manage.

One incident she told during this conversation gives some idea of the problems confronting the Austrian government. One can see that in Austria, as in other areas, the political-economic situation presents as many problems as technical operations. Only in this once-occupied nation, Communism has thrown in extra hazards. This story Dr. Ottillinger tells may give you courage or comfort — courage to act if you run into similar tactics, and comfort for many to know their problems are not quite so bad as they might be.

But first, you must hear about Dr. Ottillinger, a vivacious and attractive brunette, who at 39 has one of the important jobs in her country. She graduated during World War II as an economist and worked for the Ministry of Commerce. When the war ended she became head of the Economic Planning section where she was in charge of plans to rebuild the Austrian Steel industry. (The present healthy status of the Austrian steel industry testifies to her success in this job.) During this time Dr. Hans Igler, now general manager of the holding company for all Austria's nationalized industries, was one of her assistants.

In 1948 while traveling from the American Occupation zone to Vienna, in the company of the Minister of Commerce, Miss Ottillinger was kidnapped by the Russians and spent the following eight years in Russian prison and labor camps.

The Soviet made two mistakes. They kept her eight years, during which time she learned to speak fluent Russian and English and gained a first-hand understanding of the Communist mind and attitude. The second mistake was to let her go. With the signing of the State Treaty in 1956, Miss Ottillinger was returned to Vienna and named to the Managing Committee of the Austrian National Oil Company, her present position.

"The Russians planted people in business and industry so they could harvest a crop of economic chaos..."

Dr. Ottillinger is a powerful one-woman anti-Communist force as well as a practical and knowledgeable business woman. She was a guest of Socony Mobil in the United States and studied oil operations in this country. We selected one episode from her accounts of operating a national oil concern because it gives a vivid picture of ideological strings that tie up operations in Europe.

Or is it only in Europe?

---

part non-Communist, and the other part Communist.

The Communists called me up and told me it's impossible—we will warn you—don't do something against the secretary because we already are going again to the court and the election was all right.

Q. *How long after the election did you find out about it?*

A. More than two years were going on, because then already was the next election. And now it was a difficult moment. The three people elected in this election which was wrong—they were again candidates for the next election. And the next election should begin on Monday. It was necessary to work quickly. If the guilty weren't released from the company they could be elected anew and then they would be elected lawfully. I could not then remove them from the company because the law was for them if they are candidates of the workers and they have elected them. So it was very necessary to handle quick—you see?

So I have written the letters that released the three and the letters I have written say they were swindling by an election, and this is against the law.

Though I have written these letters and they have also been signed by another director of the company, I do not mail them but put them in the hands of my chief of employee relations because I am doubtful about it, you see.

Q. *You wanted to be able to swear they received notice that they were fired?*

A. Yes. If they don't get it in hand on the right date, they could say they didn't get the releases. There would be a new election, new candidates and I couldn't move them. So it was necessary to get these letters directly to the ones concerned. That night we found one of them — of these people — and put in his hands his letter. He was released, but then I hear that they will make a general strike in the company unless I take back the three people. So I decided—no, we will not do it.

During the Saturday and Sunday we worked together with the Interior Minister and surrounded the whole oil field in which the new election was going on with police. This we are doing so that the new election will now be right and no force will be used on the workers. It turned out to be right thing to do because the Communists already sent here all their party members to secure this election.

Monday — early morning, 5:00 o'clock—I was already in the field—I went by car there to the transportation station where drilling crews came to work. This transportation station and a tank farm were the two most important places, and they were full of Communists.

As I came up to the outer gates they were about to close and I said to my chauffeur "Quick, go in," so we made it into the enclosure where cars were standing to take the workers to the field. I was surrounded by the cars and the chauffeurs.

I came out from my car, stand in the middle of the place and said "Good

PHOTOS COURTESY
GENERAL PETROLEUM CORPORATION

morning, what's the matter—why you are not going to work?" (Already we had told them that who will not go to work, will be released.) So the chauffeurs were afraid — they didn't know what had happened and I am here as the manager of OMVAG. They didn't know what to do, but they got in the cars and moved them. I got in my car and went to the drilling section, where all the drillers were.

Here in this place was the election boss. All people can hear the election and they collected in groups and it was told to them from the Communists that no car will come and if cars are not coming they can begin to make trouble. But suddenly gates were opened and the chauffeurs drove the cars within the enclosure where the Communists said they would not come. People don't know what's happened now, so then after the cars, I went in.

"Good morning, what's the matter, how is the election? Is all things all right? Yes?"

Nobody knows what's happened so they get in the cars and moved out to the fields to work.

The first fight was won but then the three Communists which were released they came with a member of the Parliament—of our Parliament—a Communist member, and he told me, "You have not done right in sending these letters of release."

So I told to this Communist, "Be quiet and don't speak because if the three had been in Soviet Union they had get for this 25 years hard labor. Now they have the luck to be in a capitalistic country and they have a possibility to go to court and sue if they are not satisfied."

And then they asked me to get in and get some towels for hand washing.

Q. *I suppose this was mostly to irritate you?*

A. Yes, and I told them during election it's impossible — you can get it

"I was surrounded by cars of the drilling crews and their chauffeurs."

after election. "But I'm wondering" I say "you were 10 years under the Russians and you earned so little that you had only one towel for hand washing and not more?"

That makes everybody surrounding these people laugh—you see. And so, I went in my car and back to Vienna.

But I was in Vienna only a half hour when a telephone call came that in the tank farm, which is the most important point in our company, because the oil from the oil fields are going through this tank farm to the refinery and from the refinery came all products to the tank farm and were distributed from here. So it is the most important point of our company.

Everybody was in general strike. So I jumped again in my car and went there. Nobody worked — there were only the chief of this tank farm who worked, his assistant, and one other.

"Do you mean you earned so little under the Russians you had only one towel and not more?"

All of the other people were not working and were shouting. "This is a club house, a great club house."

Q. *What do you mean?*

A. This is such a house in which people can have eating and drinking and noise.

Here they had moved out every table and were yelling and having a meeting. So I came in and said to the people—"What's the matter, why is nobody working? Why haven't you done anything?" So I called in to headquarters to send me workers from there to go to the pumps to get the pumps moving, etc., but it wasn't possible because the other side had already surrounded the whole tank farm by strikes.

I don't know how they are called in English.

Q. *Pickets?*

"I spoke one hour . . . we pay the strikers for the one hour in which I have spoken."

A. Yes, yes. They were before the farm and nobody could go in and nobody could move without their permission. They were workers — yes, and then the leaders came to me and they stand before me and I said "Sit down, what's the matter? Why are you doing so?"

They told me "We will strike 'til you have taken back the three people you have released."

I told them "You can wait a long time. I will not take them back, only if the court will write a decision that the first decision wasn't right. If it be so, then I will take them back, because Austria is a country in which the law is very high and I will always do what the law demands from me. If the decision of the court is not changed they will be released and nobody can threaten me to bring them back."

I was sitting in this room so angry because I can do nothing. They are shouting and haranguing inside. So I sent some people there to ask them if it's possible to come into the meeting, because as a member of board I had no right to go to a worker's meeting—I must get an invitation. So they allow me to come in.

I will never forget this picture. I came in and more than 300 people were collected here, and they have made a row. When I came in they are shouting at me, whistling at me, pounding the earth, shaking their fists at me, and shouting and shouting so that I thought the ceiling would come down. Nevertheless I went through all the crowd, stood before a table, and looking at them with half-closed eyes, I shouted at them—"Silence!"

They were so astonished that I was speaking in such a manner that they were quiet for one second. It was enough for me to begin to speak. I spoke one hour. I told them why I had to do what I did in releasing the three

"In our country we are so free even Communists are free."

men. I told them they have done a great crime to swindle an election because an election must in a free country be free and fair. If somebody can swindle an election we are lost. If the leaders are punished for this, remember that it is good they are not thrown into prison. They can fight against the sentence of the court. But while the sentence is on my table they will be released and I will not take them back. I tell them I don't fear them.

"I came here to tell you personally to your face that I am right and that I will never take the three back unless the sentence of the court is changed."

They shout back that it isn't necessary to be afraid of them. I tell them I'm not afraid of them. I tell them nothing will be done if the sentence will not be changed.

Then they shouted at me—"Yes, you will take our advantages."

Q. *This means seniority and benefits?*

A. That is right. And I told them "Advantages, my dear workers, what were advantages when you were going 'til you were half bloody in the dirty street, when you washed your face in dirty water? You see, you had nothing at all. Nothing was clean. Your equipment wasn't repaired and it was always in bad condition. Look what you have now.

"But, my dear workers, if you wish you can go to the Soviet Union. Nobody will hold you back. You can go there if you are thinking everything is so wonderful and, please, the way is completely free, but I will tell you the truth to your face, there is nowhere in the world better to live for a Communist than in a capitalistic country where he can make trouble against everybody. This is a very agreeable work to have all good things from such country and to have no responsibility except to make trouble."

And then they told me, "You will sell us for other interests."

Q. *I don't understand this.*

A. They mean (that) they are afraid for their jobs. I say "Nobody in the company can tell that I once had given a worker not my best effort—that I have not valued him if he was a good worker and if he was an honest man. Have I not shown by my attitude that I was for your interests? But, my dear workers, I ask for my person the same right as you are asking from me. If I, as a member of OMVAG, came in some place of our company it's forbidden to shout at me, whistle at me, yelling and behaving in such a way as you have done."

At this moment I put my fist on the table in such a way that I get a bloody finger, you see. They have seen that I was angry and so they told me, "It is not against you. It is only we have this meeting and it has excited us." So I said "Good. I will excuse you, but for the future I will not take such behavior."

Then I ended my speech. It was more than an hour, and after this I went out and then after 10 minutes—they had a meeting 10 minutes long and decided to break up this general strike and to await what the court will say.

The Communist leader called to me and said, "This was the last time, Dr. Ottillinger, that we will give you permission to speak before our people."

He was outraged because it was the first time at this tank farm that people dared to vote against the Communists and what they wished, you see.

After this the most dangerous situation was over. It was more than 14 days that we were fighting. The Communists had meetings and made plans. They wanted demonstrations and more strikes, but people already had seen enough. They were not behind them and the strike was broken completely. As for the strikers, we exhorted the board not to pay them for the hours in which they didn't work, but to pay them—and this was my proposal—for this one hour in which I have spoken. So people said "That Margarethe, if she had spoken two hours it would have been better."

The good advancement of Communists in all countries is only because the other side is so fearing. They are living from the fears of the other side. We are people living near them and we have anxiety about the trouble they make, but it is not necessary to fear somebody if you have the right on your side. Not to fear the Communists is the best way to fight against them.

I will not say everybody has not the right to have his ideas but I also have the right to fight Communist ideas.

Remember, the Communists are speaking for another country. They are not fighting for our country, Austria, they are fighting for the interests of the Soviet Union and for this I am fighting against, you see.

In our country we are so free that even Communists are free. In the OMVAG the Communists will be treated well and nothing done against them. But if one does something wrong—as those who stole the election did—he will be moved out.

And so it is. ★ ★ ★

Companies Make Sharp Come-Back

Oil concerns show 26 percent increase in earnings for first half over 1958

Ernestine Adams

AS PRESENTED BY 70 COMPANIES, the petroleum industry increased earnings in the first half 26 percent over 1958. This appears to be a radical change, but last year was a recession, most of the downturn coming in the first half.

Revenues for the 1959 period rose 9 percent above 1958.

More important than these data is a small widening of the profit margin. In 1959 earnings were 8.8 percent of revenues; in 1958 they were only 7.5 percent, probably a record low.

Although still too low to be healthy, the 1.3 percent increase in the profit margin is encouraging. In recent years there has been a steady erosion of the profit margin—from 10.7 percent in 1955 and in 1956 to 10.0 percent in 1957 and 8.2 percent in 1958.

This narrowing trend has taken place at a time when increasing costs make it necessary to finance more and more replacement of plant and equipment with earnings. It is also a time when need of research funds has grown sharply, requiring large amounts for investment as well as expenses for a department whose production is nebulous and whose profits are long term and often intangible.

Another sobering comparison is first half figures for 1957 and 1959.

Sales and other revenues for the first six months of 1959 are *19 percent more* **than those of 1957.**

Earnings for the same period in 1959 are *16 percent less* **than 1957.**

So the petroleum industry, with a persistent upcurve in volume, has a fluctuating earnings record and a dragging profit margin.

Capital Expenditures

A fairly recent innovation in first half reports is an estimate of capital expenditures for the period. This provides an idea of the trend.

Jersey Standard, whose capital expenditures usually comprise 10 to 15 percent of the industry's total, spent 20 percent less for exploration, property, plant and equipment in the first half of 1959. Total was $426,000,000 compared to $532,000,000 in 1958.

Gulf had capital outlays of $162,841,000, down from $217,829,000 the first half of 1958.

Union of California showed an increase of 65 percent in capital and exploration expenditures — $49,968,000 compared to $30,268,000 in 1958.

Smaller companies generally followed Union of California's pattern—had increased expenditures. Olin spent $1,058,000 the first half of 1959 compared to $671,000 in 1958; Ambassador spent $3,679,000 compared to $2,782,000; Woodley, $3,850,000 compared to $3,371,000; Union Oil and Gas of Louisiana, $9,173,000 compared to $6,453,000.

Texas Gulf was an exception. It had capital and exploration expenses of $6,800,000 the first half of 1959 compared to $7,200,000 in 1958. Still, this is more than half the $7,076,000 estimate for the entire year of 1959.

Drilling Increases

Drilling activities are up and due for a rise in the second half.

During the first half, Sunray drilled or participated in the drilling of 115 net exploratory and development wells, 21 percent higher than last year.

The Conoco report said: "Intangible drilling costs, which Continental charges against current earnings, amounted to $19,946,000 during the first half of 1959, or $4,820,000 more than in the first half of 1958."

General Crude reported: "Although our drilling activity in the first half was relatively low, a sizeable increase is anticipated for the balance of the year."

TXL's drilling program is about the same for both this year and 1958 (89 net wells) but a greater proportion of exploratory wells are planned.

Company Comments

Improvement in 1959 figures are due as much to economies as to increased sales, it appears from the first half reports. Here are comments from company officials:

Sinclair: "During the six months under review, operations of the oil industry were subjected to two major adverse influences — an oversupply of crude oil and refined products, and a consequent deterioration in prices. However, increasing demand for petroleum products gathered momentum in the second quarter and is exceeding most industry forecasts made earlier in the year."

Macmillan: "Your company continued its concerted drive to reduce costs. . . . Despite the implementation of the Mandatory Oil Import Program there appears to be no indication of prices firming as inventories are still increasing."

Bishop: "Decrease was due to crude oil price cuts and reduction of allowables in Canada and Texas. Operating expenses were reduced."

Standard (Ind.): "Even allowing for these unsettling factors (strikes at four refineries), the net effect for the year as a whole should be to achieve a sound recovery from the recession levels of last year."

Gulf: "Increased earnings are mainly attributed to the company's improved domestic operations, which showed better results despite a 35-day strike at Port Arthur Refinery early in 1959 and declining product prices throughout the second quarter."

Tidewater: "Factors in the substantial improvement in earnings over 1958 were increased crude oil and natural gas production, higher sales volume and improved refinery throughput."

Atlantic: "General conditions within the oil industry during the first half of 1959 were considerably better than last year. Demand for petroleum products was up about 6 percent. However, a build-up of excess inventories by the industry in the spring led to some product price deterioration during the second quarter, thus hindering expected profit improvement."

Louisiana Land and Exploration: "While oil production increased, price realization was about 15¢ per barrel less due to the crude price reduction in August, 1958 and other price changes."

Union of California: "Earnings in the first half of 1959 were about 16 percent over the first half of last year, exclusive of a nonrecurring capital gain recorded in that period." (This explains decrease shown in table.)

Delhi-Taylor: "An increase of 6 percent in domestic demand, plus some recent reductions of refinery runs, helped to stabilize weak product prices."

Skelly: "Prices were fairly stable through most of the second quarter, while production allowables were substantially above those of the same period in 1958."

Signal: "During the last half of 1959 we expect to show an increasingly favorable earnings comparison with 1958 figures. This would be due primarily to increased production from operations in Lake Maracaibo, Venezuela."

Woodley: "While our net earnings for the first half of 1959 were substantially higher than in 1958, it would

be unsafe to conclude that earnings will hold at the same rate for the remainder of the year."

Universal Consolidated: "Excessive imports have contributed their share of heavy additions to inventories on the West Coast and a general weakening in prices of crude oil and petroleum products in the California area."

Phillips: "The higher 1959 profit from operations reflects a rise in petroleum products sales of 5 percent. The 1959 earnings also benefited from capacity production of our uranium mill, which started operating in mid-1958."

American Petrofina: "With the continuing effects of the operating economies which were adopted in 1958, the advantages of the crude oil import allocation and a strengthening in product prices, earnings for the last half of the year should materially exceed results for the first six months."

Monterey: "Reduced selling prices for oil and an increased level of exploration activity caused a lower net return. Net income for the quarter ending May 31, however, was up 7½ percent." (Table shows 6-month figures.)

Texas Pacific: "We have offset to some extent the consequent reduction in our gross income by an increased emphasis on gas prospects, our sales of which have been substantially increased during the past several years."

Colorado Oil and Gas: "The Government's restriction on importation of crude oil and products has had a stabilizing influence on the domestic industry."

South Penn: "Such reduced earnings did not result from normal operations but from contributory causes, principally increased intangible development costs and initial costs of the exploratory drilling program."

Douglas: "Increase in sales, however, was not sufficient to offset the extremely unfavorable economic conditions facing the entire petroleum industry and an unfavorable Navy crude oil contract."*

Ashland: "Results of our operations are gratifying in view of the fact that price levels of gasoline and heating oils during much of the quarter (ending June 30) were at lower levels than have prevailed for many years."

Ohio: "Partially offsetting increases, however, were higher operating costs and increased expenses of a stepped-up exploratory program, particularly in foreign areas. A nine-cent-per-barrel reduction in the average price received for crude oil and natural gas liquids also tended to limit the increase in earnings." ★ ★ ★

*Douglas is not included in table because comparable figures were not available. The company lost $436,102 in the fiscal year ending March 31, 1959. The Elk Hills contract accounts for more than entire loss.

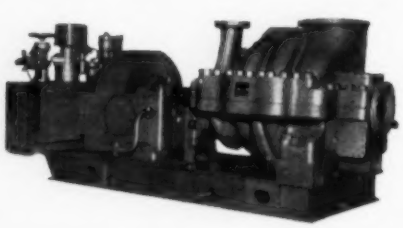
FIRST HALF REPORTS OF PETROLEUM COMPANIES

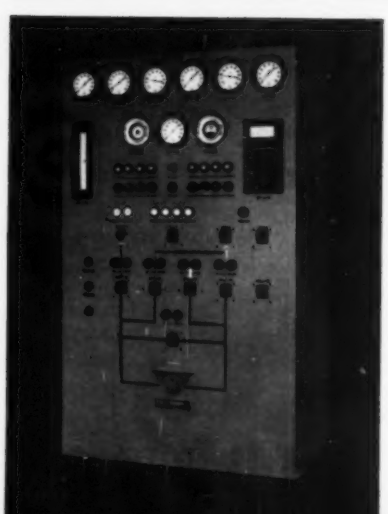
Company	Gross income ($1000) 1958	Gross income ($1000) 1959	% change	Net Income ($1000) 1958	Net Income ($1000) 1959	% change
Ambassador	$ 1,592	$ 2,587	+ 62	(685)	180	+1262
Amerada	51,072	52,526	+ 3	9,850	11,662	+ 18
American Petrofina	33,538	38,349	+ 14	(297)	355	+ 220
Anderson-Prichard	33,677	36,025	+ 7	1,377	3,044	+ 121
Argo	6,242	7,064	+ 13	2,330	2,411	+ 3
Ashland O & R	134,294	152,599	+ 14	3,780	7,300	+ 93
Atlantic Refining	264,427	277,527	+ 5	7,667	16,400	+ 114
Aztec	1,583	3,942	+149	591	2,657	+ 350
Bishop	1,141	962	— 16	45	(19)	—
Blackwell	722	780	+ 11	(10)	132	+ 142
Champlin O & R	37,743	42,796	+ 13	2,865	4,300	+ 50
Cities Service	518,709	507,930	— 2	18,067	18,906	+ 5
Coastal States	1,443	1,846	+ 28	459	634	+ 38
Clark O & R	4,249	—	—	222	—	—
Colorado O & G	15,932	21,914	+ 38	595	1,034	+ 74
Continental[5]	359,000	383,793	+ 7	20,653	29,160	+ 41
Cosden[2]	38,829	40,489	+ 4	2,168	2,289	+ 5
Crescent	—	—	—	146	1,382	+ 847
Delhi-Taylor	32,171	42,949	+ 34	(715)	1,460	+ 304
Drilling & Explor.	4,854	5,115	+ 5	306	359	+ 17
Eason	2,205	1,941	— 12	422	278	— 34
Felmont	4,779	4,742	— 1	942	1,315	+ 40
Fifteen Oil Co.	1,215	1,234	+ 2	102	122	+ 20
Frontier	13,443	15,289	+ 14	166	241	+ 45
General American	11,268	13,310	+ 18	2,474	2,732	+ 10
General Crude	5,448	6,891	+ 26	974	1,719	+ 76
Getty	20,756	21,157	— 9	7,980	4,296	— 46
Gulf	1,302,263	1,343,570	+ 3	115,737	141,814	+ 23
Honolulu	19,909	22,288	+ 12	5,586	6,444	+ 15
Intex	1,432	1,239	— 16	425	154	— 64
Leonard Refineries	26,353	27,846	+ 6	777	618	— 20
Louisiana Ld. & Expl.	16,048	18,255	+ 14	8,861	9,169	+ 4
Macmillan	7,777	6,952	— 11	(120)	116	+ 197
Maracaibo	935	891	— 5	139	139	0
Midwest Oil	9,155	10,544	+ 15	3,347	3,471	+ 4
Monterey[1]	10,986	11,502	+ 5	1,358	1,247	— 8
Mountain Fuel Supply	14,801	17,250	+ 17	2,328	2,734	+ 17
Ohio Oil	133,406	143,990	+ 8	15,087	18,556	+ 23
Olin Oil and Gas	17,622	20,653	+ 17	1,011	2,026	+ 100
Phillips	512,433	597,579	+ 17	36,412	53,209	+ 46
Plymouth	43,270	48,556	+ 12	1,520	2,184	+ 44
Producing Properties[3]	2,246	3,755	+ 67	176	162	— 8
Pure	237,443	253,236	+ 7	10,675	13,148	+ 23
Quaker State	24,228	27,869	+ 15	811	1,004	+ 24
Richfield	123,288	131,357	+ 7	10,410	10,695	+ 3
Shamrock[1]	27,971	28,303	+ 1	4,517	4,786	+ 6
Shell	804,261	898,883	+ 12	53,872	69,187	+ 28
Signal	72,008	81,919	+ 14	8,326	8,669	+ 4
Sinclair	597,271	627,617	+ 5	22,356	27,032	+ 21
Skelly	122,404	131,115	+ 7	10,549	14,529	+ 38
Socony Mobil	1,415,650	—	—	63,000	77,100	+ 22
South Penn Oil	26,517	28,547	+ 8	1,633	1,162	— 29
Southland Royalty	4,448	5,073	+ 14	1,857	2,245	+ 21
Standard (Calif.)	808,183	812,669	+ 1	116,736	118,153	+ 1
Standard (Ind.)	919,910	997,037	+ 8	52,423	78,851	+ 50
Standard (N. J.)	3,720,000	3,956,000	+ 5	249,000	315,000	+ 27
Standard (Ohio)	191,457	200,613	+ 5	11,436	13,290	+ 16
Sun	334,671	385,315	+ 15	11,560	21,974	+ 90
Sunray Mid-Cont.	180,917	193,416	+ 7	19,251	19,936	+ 4
Superior	54,231	71,843	+ 32	8,800	16,207	+ 84
Texaco	1,027,116	1,327,691	+ 29	138,089	162,723	+ 18
Texas Gulf	7,903	8,774	+ 11	1,617	2,092	+ 29
Texas Natural Gas[1]	—	—	—	2,446	2,458	none
Texas Pacific C & O	10,800	13,215	+ 22	2,353	3,642	+ 56
Three States Nat'l Gas	2,212	2,548	+ 15	226	178	— 21
Tidewater	263,713	278,416	+ 6	279	18,633	+6578
TXL[1]	5,470	6,910	+ 26	1,593	2,243	+ 41
Union Oil of Calif.	201,127	210,396	+ 5	11,457	10,772	— 6
Union O & G of La.	16,637	22,676	+ 36	4,091	6,675	+ 63
Universal Consol.	4,378	4,173	— 5	1,123	1,721	+ 53
White Eagle[6]	6,799	6,825	0	195	244	+ 25
Wilcox	3,790	3,481	— 8	369	423	+ 15
Woodley	3,675	4,444	+ 21	1,281	1,755	+ 37
TOTALS	13,436,247	14,661,738	+ 9	1,094,896	1,380,157	+ 26

(loss)
[1]6 months ending May 31
[2]6 months ending April 30
[3]6 months ending February 28. Oceanic Oil Company acquired in 1958.
[4]1st quarter net of $8,504,826 included non-recurring profit of $2,409,000
[5]1958 for companies acquired.
[6]6 months ending March 31

Background: *Compressing isobutane in refrigeration system of alkylation plant of Petro-Tex Chemical Corp.* **Foreground**: *Cutaway of high-pressure seal of Cooper-Bessemer Type RD Centrifugal Compressor.*

Matched to your needs . . . *A wide range of types and sizes of Cooper-Bessemer Centrifugal Compressors are available to assure optimum performance on your processing or air supply application.*





Undivided responsibility . . . *We can engineer the entire compressor installation, including drive and controls. Cooper-Bessemer En-Tronic® Controls* provide any degree of automation.

John Fullemann, *Chief Turboproduct Design Engineer, right, and* Kenneth Stevenson, *Turboproduct Designer, The Cooper-Bessemer Corporation, discuss...*

How reliable Cooper-Bessemer Centrifugal Compressors aid 'round-the-clock processing

For example, here's the picture at Petro-Tex Chemical Corp., Houston: The entire sulfuric acid alkylation plant banks on the dependable performance of the Cooper-Bessemer Type RD Centrifugal Compressor which handles isobutane for refrigeration. This unit operates on a continuous, 24-hour basis, handling 11,125 cfm and boosting pressure from 16.2 to 98 psia. Its constant availability is a must.

Of course, many things go into Cooper-Bessemer centrifugals to assure this kind of reliability. For example, take the two-sleeve oil film type seals shown in the illustration. This Cooper-Bessemer design is capable of sealing against pressures of more than 1000 psi, for utmost dependability in processing service.

Bear in mind, too, that the performance of Cooper-Bessemer equipment is backed by an unsurpassed service organization to help protect your plant investment and assure optimum operating economy. For further information, call our nearest office.

BRANCH OFFICES: Grove City • New York • Washington • Gloucester • Chicago Minneapolis • St. Louis • Kansas City • Tulsa • New Orleans • Shreveport • Houston Greggton • Dallas • Odessa • Pampa • Casper • Seattle • San Francisco • Los Angeles

SUBSIDIARIES: Cooper-Bessemer of Canada, Ltd.... Edmonton • Calgary Toronto • Halifax
C-B Southern, Inc.... Houston
Cooper-Bessemer International Corporation... New York • Caracas • Mexico City
Cooper-Bessemer, S.A.... Chur, Switzerland • The Hague, Netherlands

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS • DIESEL • GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE OR MOTOR DRIVEN

Engineers and Scientists | OPPOSE UNIONISM

Survey reveals a strong minority of one in five favors collective bargaining either through unions or professional societies

A MAJORITY OF ENGINEERS and scientists are opposed to collective action to improve their salary and social status, but the idea is favored by a surprising minority of 19 percent. These results came from a University of Michigan survey covering 10 major firms. None were in petroleum; they included automotive, electronics and public utilities industries.

About half the minority (10 percent) think in terms of collective bargaining along union lines. The rest (8 percent) think their professional societies could do more collecting and distribution of salary and related information to their members and management.

Half those interviewed were strongly opposed to any form of collective bargaining for scientists and engineers, and another large group (29 percent) were mildly opposed to this idea. (Three percent had no opinion.)

Preliminary findings of the U-M study were disclosed by Prof. John W. Riegel, director of the Bureau of Industrial Relations. The bureau will publish a complete analysis of interviews with more than 250 scientists and engineers on this question in June.

Other highlights were:

1. There are no significant differences between scientists and engineers in attitudes toward unions.

2. There is no significant relationship between ratings of an individual's performance and his attitude toward collective bargaining.

3. There is quite a high relationship between how an individual feels about his salary and how he views unions.

4. There are wide differences in attitudes toward collective bargaining among scientists and engineers working for different firms, based largely on satisfaction with salary and treatment by management.

The reason most often cited for favoring collective bargaining, presumably by some form of union, was to get higher salaries and more equitable salary adjustments.

Communication with management and the desire to obtain more favorable terms of employment were also mentioned by this group.

A second, somewhat smaller group favored action by their professional societies to improve their income and status. As one man put it: "Engineers as a group should have representation, but not in the form of a labor organization. For our protection, we need something like the American Medical Association. The organization should not be dominated by top management."

Several persons in this group felt their professional society should have machinery for learning the opinion of its members and for presenting this feeling to management. Others felt engineering and scientific societies should be more vigorous in advocating and policing professional standards, and in the use of publicity to build prestige for their profession.

In view of the critical importance of engineers' and scientists' satisfaction with pay, their employers' administration of salaries should be according to sound and tested methods. Presumably these professionals should know the bases on which their rates are determined, Riegel noted:

"Better job classification and salary surveys by employers and professional societies would improve the knowledge of the market for professional services. This would also reduce existing, unwarranted differences in salaries paid for similar work.

"Executives also can explain the evaluation procedures which they use in setting rates for uncommon positions held by engineers and scientists.

"Possibly the most difficult part of salary administration for the managers of professional work is the adjustment of each individual's pay so that it reflects his performance and contribution, and yet remains within the approved range for work of that type and grade. The interviewees clearly indicated their desire to be informed regarding the merits and shortcomings of their work, and the bearing of their achievements upon their salaries."

These were the principal reasons given by scientists and engineers opposed to collective bargaining:

1. It is unnecessary, would offer no advantages, and might even be harmful — mentioned by nearly half of all those interviewed;

2. Under it, salaries and promotions would not reflect the individual's responsibilities, performance, or qualifications — cited by one-third of those surveyed; and

3. It would reduce professional productivity and development — given by about one-fifth those questioned.

Other objections to collective bargaining included fear it might introduce "objectionable policies and practices of labor unions," restrict the personal freedom of professionals, impair their relations with management, and reduce the status of professionals in their community.

Some comments by those opposed to collective bargaining were: "Any professional can get a job elsewhere if he doesn't like his present job."

"Anyone who professes to be an engineer should be strong enough to take care of himself. He doesn't need a union to do this for him."

"Unionism would certainly stifle initiative. All the senior people would have to do is sit around."

Commenting on some of these opinions, Riegel said:

"The men who opposed collective bargaining and unionism because these would yield them no material or intangible advantages were not grounding their opinions on principle.

"On the other hand, those who said without qualification that engineers and scientists could bargain for themselves were certain their own abilities were superior to those of their fellow professionals. Many of them, being highly individualistic, rebelled at the thought of submerging themselves in a mass movement."

In general, scientists and engineers are work centered, deriving keen satisfaction from their achievements. They share managements' concern for productivity. To the extent that management gives tangible and intangible recognition to their achievement, it can motivate professions to do their best work. This, in turn, will yield them a high level of satisfaction. ★ ★ ★

A "hot" ring helps tame an old enemy

Atomic radiation helps this man do his job.

He's Dr. Hugh Macpherson, one of Standard's research engineers. The "hot" ring he's holding is an ordinary piston ring which has been exposed to atomic radiation.

By installing such radioactive piston rings in a car, our research engineers can use a Geiger counter to measure wear *as it happens* while the car is driven on the highway, in traffic, on hills — in every possible driving situation.

This research technique has taken months off the time needed to test the effectiveness of new motor oils, and it's far more accurate than previous methods.

It's one of the techniques pioneered by Standard's scientists to help defeat an old enemy—wear... to learn what it is, what causes it, how to prevent it.

Our progress has been steady. Working closely with car manufacturers, we've virtually ended the problem of wear in automobile engines.

In the 1930's, for example, cars could go only 20 to 40 thousand miles before a major overhaul. But with today's motor oils and regular oil changes, your engine can be good for more than 100,000 miles—can, in fact, outlast the car.

By such never-ending research that leads to better products, ***the people at Standard are planning ahead to serve you better.***

OIL'S FIRST CENTURY
BORN IN FREEDOM
WORKING FOR PROGRESS

STANDARD OIL COMPANY OF CALIFORNIA

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

CLARK
CLARK BROS. CO.
compressors and
gas turbines

DRESSER DYNAMICS
DIVISION
advanced scientific research

DRESSER
IDECO
DRESSER-IDECO
COMPANY
steel structures
and buildings

DRESSER
MANUFACTURING
DIVISION
DRESSER MANUFACTURING
DIVISION
couplings and rings

THE GUIBERSON
CORPORATION
oil tools, molded
rubber products

Hermetic Seal
Transformer Co.
HERMETIC SEAL
TRANSFORMER CO.
electronic transformer
development-manufacture

IDECO Inc.
IDECO, INC.
complete drilling rigs

Aglow with brilliant colors symbolizing an almost endless variety of processed chemicals, a large flask, at left, reflects the atmosphere of its refinery background. Dresser Industries, by improvement of existing lines and development of new equipment, have made many contributions to the progress of the refining and processing industries. Dresser companies provide superior products and technical services which have long been known as the standard of comparison the world over.

LANE WELLS
LANE-WELLS COMPANY
technical oilfield services

Magcobar
MAGNET COVE BARIUM CORP.
drilling mud and chemicals

PACIFIC
PACIFIC PUMPS, INC.
pumps of various types

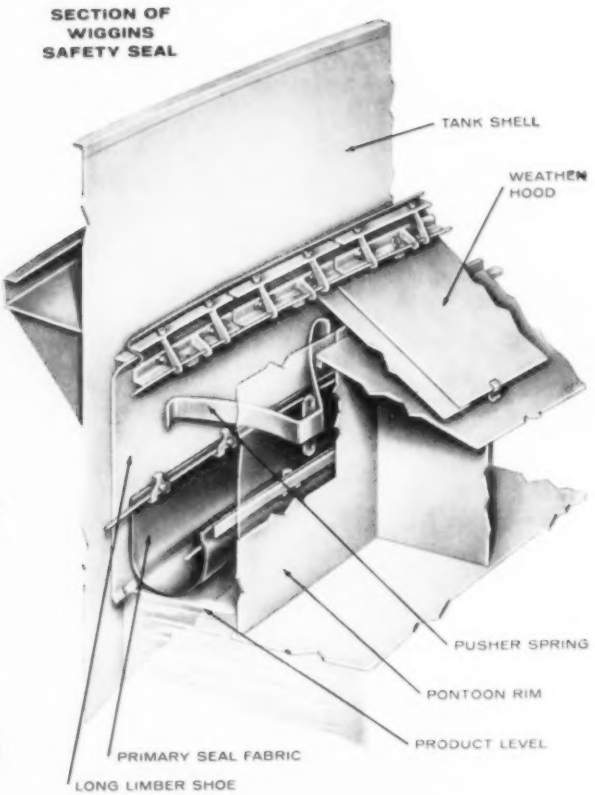
ROOTS-CONNERSVILLE BLOWER DIVISION
blowers, meters, vacuum pumps

Security
SECURITY ENGINEERING DIVISION
rock bits and oilwell drilling tools

SIE
SOUTHWESTERN INDUSTRIAL ELECTRONICS
seismic and electronic instruments

WELL SURVEYS
WELL SURVEYS, INC.
nuclear and electronic research

ONLY THE WIGGINS FLOATING ROOF *with* SAFETY SEAL



GIVES YOU MAXIMUM PROTECTION AGAINST FIRE, PRODUCT LOSS AND COSTLY MAINTENANCE

Look at these 9 points of superiority:

1. *Safety Seal* exclusive design eliminates critical vapor spaces, does away with rim fires.
2. *Safety Seal* eliminates losses from thermal breathing.
3. No metal working parts ever touch the liquid.
4. Weather hood protects *Safety Seal* fabric from the elements.
5. *Safety Seal* makes tanks safe for highly volatile, highly flammable liquids.
6. Air-vapor volume less than 10% of conventional seals.
7. *Safety Seal* is specially compounded to resist deterioration . . . much longer life than ordinary seals assured.
8. No rust or scale can deposit in the seal loop.
9. *Safety Seal* is easy to inspect, easy to maintain.

A Floating Roof is only as good as its Seal.

Wiggins Floating Roofs are in a class by themselves . . . pay for themselves with the savings they provide.

Call the nearest General American office, or write. You'll find that here, as in so many fields, *it pays to plan with General American.*

Plate and Welding Division

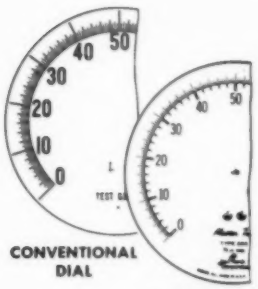
GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street • Chicago 3, Illinois

Offices in principal cities

PLATE & WELDING DIVISION GENERAL AMERICAN TRADE MARK

Presenting New MARSH "*Master-Test*" SERIES
of extremely accurate test gauges

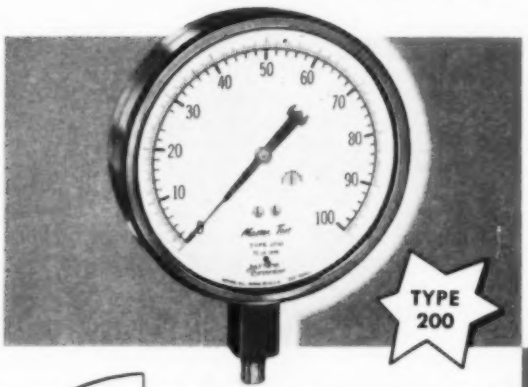


Crowning achievement in instrument making... this superb series of test gauges developed to meet today's exacting requirements of instrument men throughout industry. Accuracy and dependability beyond compare...each gauge individually dead-weight tested (think what that means!)...each gauge guaranteed accurate within ¼ of 1% plus or minus of the maximum dial reading over the entire range.

To provide reading accuracy in keeping with the accuracy of the instrument, all "Master-test" gauges have the simplified "Read-easy" dial (patent pending) illustrated opposite—a dial that can be read with the accuracy of a caliper, yet with the ease of a clock.

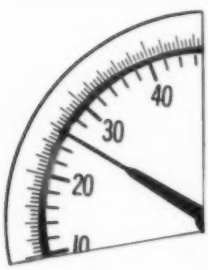
To further increase accuracy, three advanced means of reading have been developed as described below: the "twin-tip" pointer; the mirror path; the non-parallax dial.

"Master-test" gauges are available in sizes 4½", 6", 8"... in all standard ranges from 0-15 to 0-30,000 psi... in vacuum and compound types... in a full range of case patterns. Ask for 20 page bulletin.



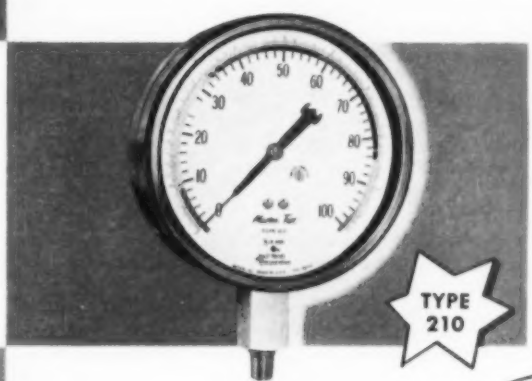
← with "Twin-tip" pointer

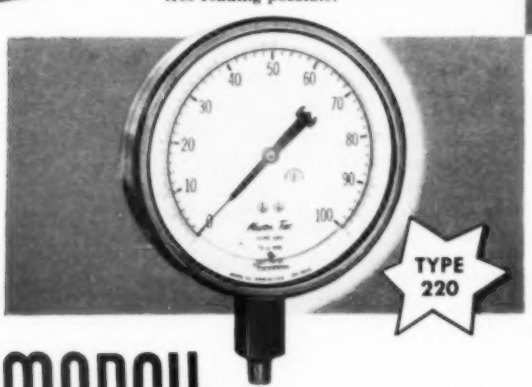
The most common error in reading pressure occurs when the observer reads from an angle rather than "dead on". This Marsh "Twin-tip" pointer enables the operator to know when he is dead on by lining up the two tips so that only one is visible. The twin-point arrangement is similar to the sights on a rifle.



with mirror dial →

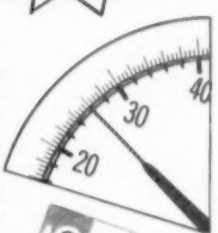
Another method of insuring accurate "dead on" reading. Knife edge pointer is reflected by the mirror path. When reflection is not seen, reading is dead on and true. The ease and accuracy with which the mirror dial may be read cannot be duplicated by any other mirror type dial. It is the combining of the mirror path with the exclusive Marsh "Read-easy" dial that makes this faster, error-free reading possible.





← with "Non-parallax" dial

This Marsh development eliminates mistakes in dial reading even if read at an angle. To accomplish it Marsh engineers designed a clear Plexiglas insert placed, as shown, over the fine graduations so that they appear to be at the same level as the pointer regardless of the viewing angle. The "Non-parallax" dial provides the easiest and most accurate dial reading available.



Ask for this 20 Page Bulletin

MARSH

THE STANDARD OF ACCURACY

MARSH INSTRUMENT COMPANY, Dept. M, Skokie, Ill.
Division of Colorado Oil and Gas Corporation • **Marsh Instrument & Valve Co., (Canada) Ltd. 8307 103rd St., Edmonton, Alberta, Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas**

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

"New Economics" Is Throwback

Henry Hazlitt takes Keynesian theories apart and finds they produce inflation and unemployment . . . but they are still being used

SUBSTANTIAL LACK of general knowledge of economics in this country does not prevent us from being a creature of its whims.

The two greatest changes in our national history turned upon economic theory.

In the 18th century Adam Smith wrote *Wealth of Nations,* a protest against mercantilism, and set out the proposition that man could provide more for himself than the state could provide for him. Probably as much as any one thing, this new idea inspired the American Revolution.

Putting the theory into practice the United States plunged ahead of the world of nations in living standards.

In the 20th century another economist, Lord Keynes of Great Britain, took another view of economics in his *The General Theory of Employment, Interest, and Money* and led us back to state paternalism.

Now Henry Hazlitt, an economics writer, spends a big book, *The Failure of the "New Economics."* (D. Van Nostrand Company, Princeton, New Jersey. Price $7.50) with a logical analysis of the Keynesian fallacies.

But logic, dear friends, never led people to revolt nor hypnotized them with the lure of an easy life.

Adam Smith held aloft a glittering idea that a peasant could own property and profit by his own labor and investment. Revolutionists wave the same prospect today — except the state gives the property.

Lord Keynes, according to Hazlitt, presents a *General Theory* whose great virtue is consumption, extravagance, improvidence. The great vice is saving, thrift, "financial prudence."

Our national administration followed Keynesian Theory doggedly in the depression beginning in 1930. Keynes said that the more a community spends of its income and the less it saves, the faster will its real income grow. If the community spends all of the additional income provided by public works, then the multiplier of income is infinity.

The New Deal pushed public works to multiply income but mass unemployment continued, averaging 10 million from 1931 to 1940 and federal pump-priming was singularly unstimulating to the economy.

It was also a Keynesian principle to go off the gold standard, as President Roosevelt did. Says Hazlitt:

"Keynes did not think that gold had value because he could not understand the source of its value. The fact that nearly all men through the ages have valued gold only indicated, in Keynes's eyes, that they were incurably stupid. But perhaps the stupidity is with the critics of gold. It is true, as those critics are always insisting, that you cannot eat it or wear it; but it is more satisfactory than custard pies or overcoats as a medium of exchange. And it is enormously more satisfactory as a medium of exchange and a store of value, as we shall see, than paper money issued in accordance with political pressures or bureaucratic whim."

Lord Keynes favored investment by the State. He wrote: "I expect to see the State, which is in a position to calculate the marginal efficiency of capital-goods on long views and on the basis of the general social advantage, taking an ever greater responsibility for directly organizing investment."

Comments Hazlitt wryly:

"For people who are risking their own money will of course risk it foolishly and recklessly, whereas politicians and bureaucrats who are risking other people's money will do so only with the greatest care and after long and profound study. Naturally the businessmen who have earned money have shown that they have no foresight; but the politicans who haven't earned the money will exhibit almost perfect foresight. The businessmen who are seeking to make cheaper and better than their competitors the goods that consumers wish, and whose success depends upon the degree to which they satisfy consumers, will of course have no concern for 'the general social advantage'; but the politicans who keep themselves in power by conciliating pressure groups will of course have only concern for 'the general social advantage'."

Economist Keynes termed "an act of individual saving . . . a decision not to have dinner today."

Hazlitt calls this another fallacy, remarking:

"The matter is obviously put this way in order to make an act of saving appear to be inherently absurd. The truth is that an act of individual saving means, for the overwhelming majority of savers, merely a decision not to have two dinners today. It is much more sensible all around to put aside enough to make sure that one also has a dinner tomorrow."

Keynes advocated deficit spending as the standard recourse to cure unemployment. He believes in inflationary remedies over money-wage reductions.

As Hazlitt contends, "leading ideas put forward by Keynes in the *General Theory,* far from being advanced and original, were a reversion to much older and more primitive ideas."

Keynes moves back to theories similar to those prevalent among the mercantilists that Adam Smith had routed in his *Wealth of Nations.*

We seem to have gone full cycle.

Keynes' whipping boy was the interest rate. His attack on free interest rates, Hazlitt says, is really an attack on free markets and free enterprise.

The Failure of the "New Economics" is a book that needs to be read. For regardless of its failure, we are permeated with the "New Economics."

How long ago did you hear . . .

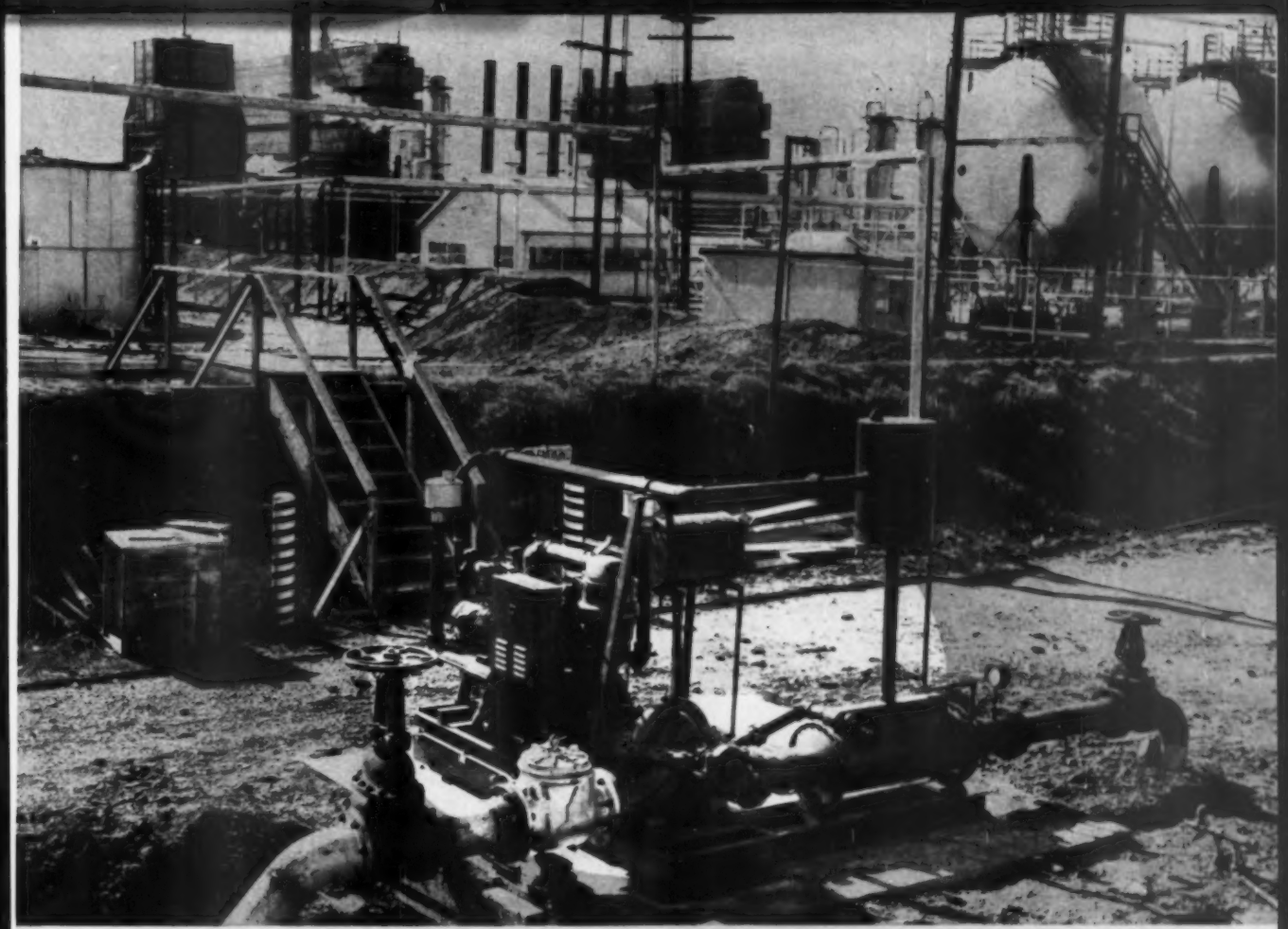
. . . Congress ask for Federal funds for public works to revive the economy?

. . . Labor union leaders ask for higher wages so wage earners could consume more and uphold prosperity?

. . . Politicians asking for cheap interest rates subsidized by government?

Hazlitt has made a contribution toward saner economics. He makes it pretty clear that what Keynes is plugging for heads straight into inflation and soft currency and unemployment.

Ernestine Adams



STANDBY PUMP, powered by International UV-549 engine, is shown in foreground of this panoramic view of Union Oil Co. refinery.

Refinery powers standby fire pump with dependable International V-8

In case of an emergency, the Union Oil Co., refinery at Santa Maria, Calif., calls on this standby Peerless fire pump driven by an International UV-549 8-cylinder carbureted power unit.

The refinery has a 50,000-gallon tank that feeds water directly to the pump that delivers it at the rate of 1,500 gpm under 100 pound pressure to all parts of the plant through a network of 6-inch pipeline. The International engine gets fuel from a 20-gallon drum mounted to give gravity feed directly to the carburetor. The engine is cooled by a jacket-type heat exchanger over the pump outlet. Safety switches shut down the engine should overheating or oil pressure failure occur.

For the most dependable power your money can buy for pumps or pump jacks, check your nearby International Power Unit Distributor or Dealer. His 32-model line includes carbureted or diesel engines ranging from 16.5 to 385 max. hp. And all dependable International engines have one common feature: Fastest payback power.

International® Construction Equipment

International Harvester Co., 180 N. Michigan Ave., Chicago 1

A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors . . . Self-Propelled Scrapers and Bottom-Dump Wagons . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carbureted Engines . . . Motor Trucks . . . Farm Tractors and Equipment.

Management Personals

▸ In a major realignment of Sunray Mid-Continent Oil Company's supply and transportation department, **Don M. Shields,** former manager of crude oil purchases and sales, was promoted to general manager of domestic crude oil purchases and sales. **Marvin C. Jones,** previously manager of crude oil traffic for Mid-Continent Pipe Line Company, a subsidiary, was named manager of foreign crude oil purchases and sales. **J. W. Hawkins,** former manager of planning and development for Mid-Continent Pipe Line, was named manager of economics and coordination and will serve in an advisory capacity to provide cost analyses, economic evaluations, long-range forecasting and planning, computer applications and other activities.

Also promoted to new positions in the domestic crude oil division were: **D. A. Harris,** formerly assistant to the manager of crude oil purchases and sales, named manager of Oklahoma crude oil purchases and sales; **W. G. Noble,** assistant to the manager of natural gasoline and LPG sales, named manager of general lease sales and purchases; **Don M. Bones,** former assistant manager of the lease records department, manager of the division order section; and **D. R. Nett,** formerly statistical coordinator, serving now as coordinator of the crude supply coordination section.

Three new positions were also created within the economics and coordination division. Personnel assigned to these positions include: **M. E. Warr Jr.,** evaluation and computer engineer, formerly planning development engineer; **D. W. Van Vleck Jr.,** procedures and training supervisor, formerly administrative assistant for the Mid-Continent Pipe Line; and **V. R. Graham,** costs and methods analyst, former planning development clerk.

F. H. Warren

N. E. Trumbull

▸ **F. H. Warren,** formerly manager of the supply and transportation planning department and **N. E. Trumbull,** formerly assistant manager of Ohio Oil Company's Casper, Wyoming, production division were named senior planning associates. In their new positions they will conduct comprehensive studies and evaluations to assist management in the establishment of long-range goals and plans for the company and its operating functions.

P. L. Vanlue, formerly assistant to the controller of the Ohio Oil, has been appointed financial assistant to the vice president and manager of domestic production.

▸ **James C. Conner** was named to a newly established position as administrative assistant to Chairman of the Board Frank O. Prior of Standard Oil Company (Indiana). Conner will assist the chairman on handling industry activities in the field of natural gas, including the problem of governmental regulation and control of all energy resources under proposed end-use control plans. He was formerly division gas superintendent of Pan American Petroleum Corporation, an affiliate, at Fort Worth, Texas.

▸ **James W. Vickers,** formerly vice president, marketing, was elected executive vice president of The Vickers Petroleum Company, Inc. **James A. Doctor,** formerly vice president, marketing, The Champlain Oil and Refining, was elected vice president, marketing, of Vickers.

▸ **A. P. Endres** was appointed manager of public relations services for General Petroleum Corporation. He succeeds **W. B. Curtis,** who has retired. Endres also has held the positions of sales promotion clerk, advertising assistant and supervisor, sales promotion. In 1946, when the public relations department was formed, he was appointed assistant to the manager, a position he held until his present promotion.

N. O. Campise

A. P. Endres

▸ **Nash O. Campise,** Houston, Texas, was recently cited by **Lt. Gen. George W. Mundy,** USAF, Commandant of the Industrial College of the Armed Forces, Washington, D. C., for having successfully completed the college's correspondence course.

The course, entitled "The Economics of National Security," is based on the 10-month resident course conducted for selected senior officers of the military services as well as officials of the civilian governmental agencies. Campise is presently employed as a research engineer for the Houston Oil Field Material Co., Inc.

▸ **Howard W. McCullough** of Chicago, senior vice president of Brunswick-Balke-Collender Company, was elected to the board of directors of Texas American Oil Corporation.

▸ **L. Chase Ritts Jr.,** vice president and manager of the Houston division office of Pan American Petroleum Corp., was named to the advisory committee of Bank of the Southwest's board of directors.

▸ **Basil P. Kantzer,** vice president of Union Oil Company of California, and manager of the Gulf Coast division in Houston, was named to the advisory committee of Bank of the Southwest's board of directors.

▸ **O. E. Young,** assistant chief civil engineer for Humble Oil & Refining Company, retired July 24, after more than 37 years service with the company.

▸ **John H. Childs** was appointed general manager of advertising and sales promotion for Texaco Inc. A vice president of Cunningham & Walsh Inc. and account supervisor of the Texas account, Childs joined that advertising agency in 1954.

▸ **Dr. Carl H. Samans,** associate director of engineering research, Standard Oil Company (Indiana) was selected as one of two national trustees of American Society for Metals to serve for a 2-year term starting at the National Metals Congress, to be held in Chicago in November.

▸ **Lea W. Clayton,** former director of staff accounting, was named director of the new financial accounting division of Continental Oil Company's controller department. **R. P. Bowman,** former consolidation accountant, is assistant director of the division in charge of the general section. **T. R. Pickrell,** formerly staff accountant in the controllers department, becomes assistant director of the new division in charge of the corporate section.

▸ **Thomas M. Dailey Jr.,** executive assistant to the president, was appointed manager, planning and personnel department, Tidewater Oil Company. He will continue to make his office at the Los Angeles headquarters.

▸ **George P. MacKnight** has joined the public relations department of Standard Oil Company (Indiana) as advanced writer. Formerly office manager of the Chicago Motor Club's public relations department, MacKnight also has been associated with the National Safety Council, Sears, Roebuck and Company, Porcelain Enamel Institute and the American Peoples Encyclopedia.

DEATHS

▸ **David A. Garrick,** 48, president of Cherokee Laboratories, Inc., and Cherokee Steel, Inc., **William G. Wood,** 45, vice president and **Harry Richey,** 33, were killed July 3 when their private plane crashed near Republic, 12 miles west of Springfield, Missouri. Also in the plane, were **Edward F. Rogers,** 30, who died, a partner in a law firm of Rogers, Litchfield and Rogers, attorneys for the Cherokee firms.

▸ **Hugo W. Wahlquist,** 63, prominent corrosion engineering consultant with Ebasco Services Inc. succumbed to a heart ailment July 9 at New York.

▸ **William R. White,** laboratory director of Hughes Tool Company since 1942, died in Houston July 1 after an illness of several months.

▸ **Perce E. Allan,** retired, and former administrative vice president for marketing for Tidewater Oil Company, died July 12 while vacationing at his country home near Clear Lake, California.

▸ **Lorraine A. Tromley,** 51, safety engineer for the Warren Petroleum Corporation, was killed in a traffic crash near Inman, Kansas, July 11.

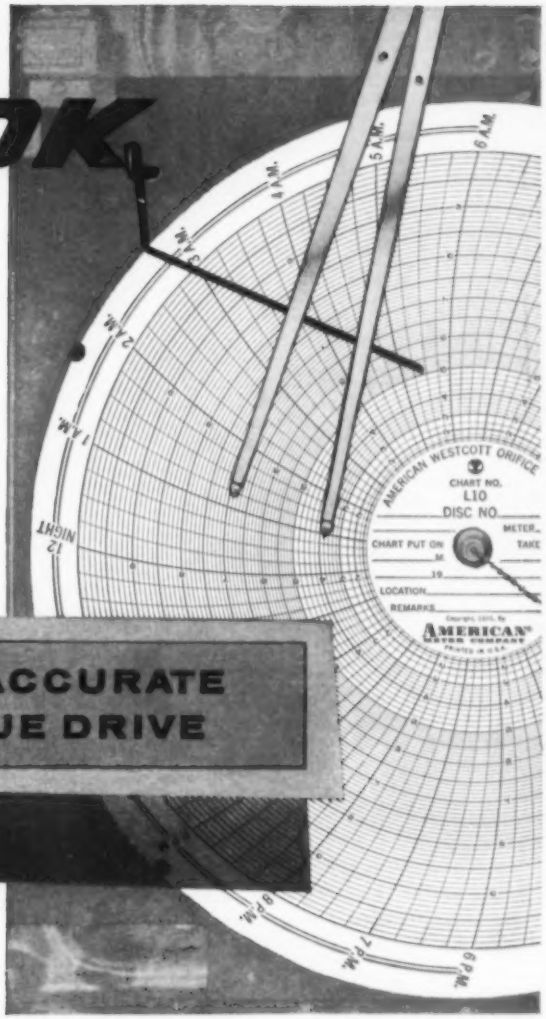
▸ **Harry Oliver Cameron,** 89, former Sun Oil Company executive who retired in 1955 after more than 50 years with the company, died July 30.

▸ **James M. Bugbee,** senior mud engineer at Shell Development Company's exploration and production research division, died in a Houston, Texas, hospital after a brief illness.

▸ **Alvin B. Calkins,** 56, district manager of oilfield sales at Houston, Texas, Chain Belt Company, died of a heart attack July 9, at Dallas, Texas.

▸ **Henry W. Pratt,** 61, sales engineer in the Boston sales district of American Oil Company, died of a heart attack in Buffalo, N.Y., July 21, while on a special assignment.

AMERICAN®
GASCLOK
POWER DRIVE



Check these features--

- **Completely self-contained gas or air-powered instrument driving and timing unit for long, trouble-free operation in remote locations.**
- **Constant high power...more than 20 times the torque delivered by conventional spring-wound mechanisms.**
- **Timing accuracy continuous...no heavy "mainspring" to weaken or run down...unaffected by a ± 20% variation in supply pressure.**
- **Self-starting...no winding or priming of power unit.**

VERSATILE • ACCURATE
HIGH TORQUE DRIVE

- **Flexibility...ideal as original or replacement equipment for strip chart and conventional circular chart instruments.**
- **Built-in durability...timing mechanism internally sealed to prevent corrosion...large area internal ports prevent clogging.**
- **Rugged dependability...all power unit parts exposed to gas are aluminum or stainless steel...inherently explosion proof.**
- **Economical...normal air or gas consumption 5 cfh...operating pressure 5 psi...rotation 2 rpm.**

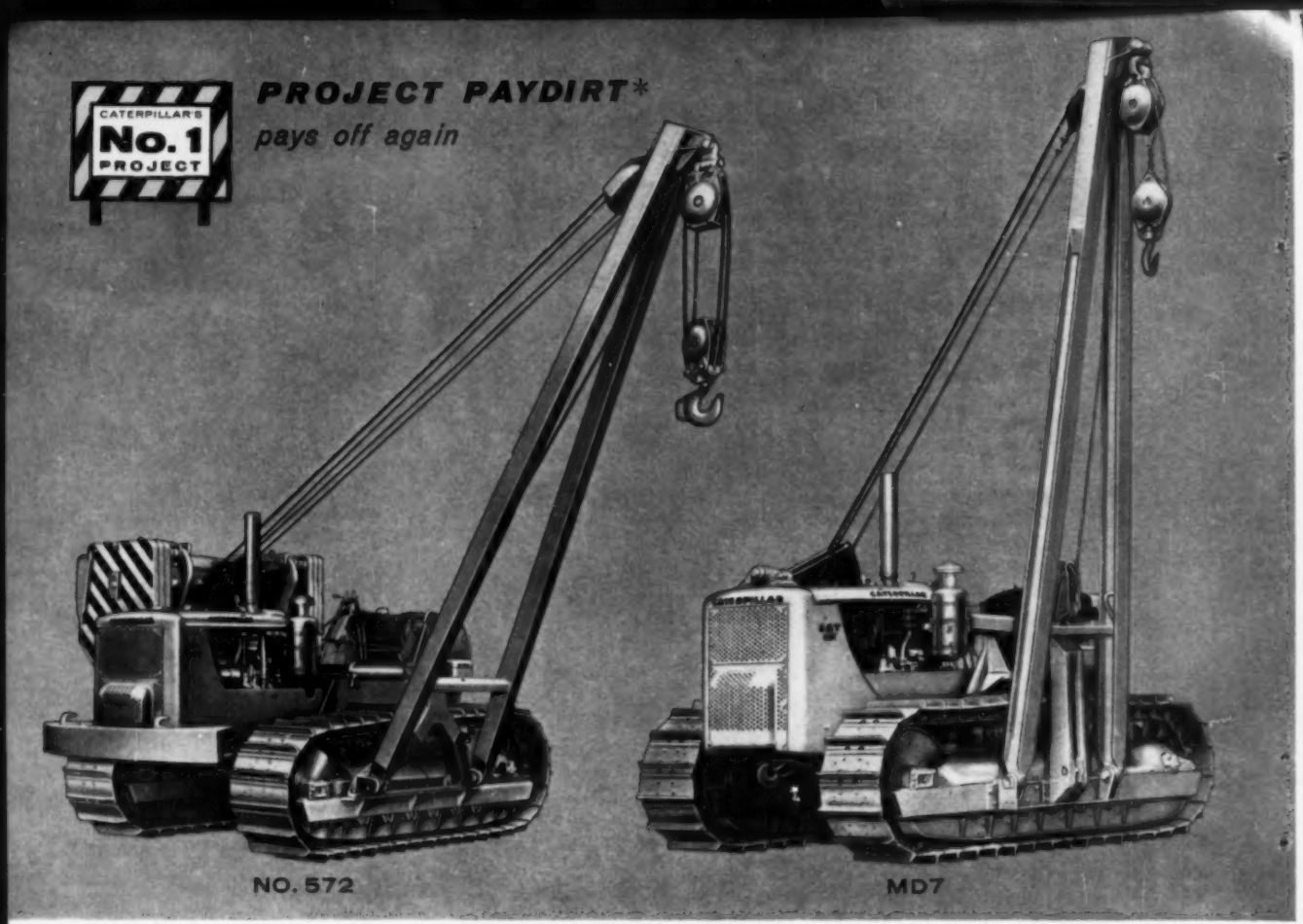
Then ask
your American representative how the versatile ***GASCLOK*** can provide new metering accuracies and economies for you.

AMERICAN METER CO

AMERICAN®
METER COMPANY
INCORPORATED (ESTABLISHED 1836)

GENERAL SALES OFFICE: Philadelphia 16, Penna. • Albany • Alhambra • Atlanta Baltimore • Birmingham • Boston • Chicago • Dallas • Denver • Erie • Houston Kansas City • Los Angeles • Minneapolis • New York • Omaha • Pittsburgh • San Francisco • Seattle • Tulsa • Wynnewood • IN CANADA: Canadian Meter Company, Ltd., Milton, Ontario • Calgary • Edmonton • Regina

SUPPLIERS TO THE GAS INDUSTRY for Ironcase, Tinned Steelcase, Aluminumcase and Welded Steelcase Meters • American-Westcott Orifice Meters • Instruments • Reliance Regulators • Apparatus • Valves



2 NEW MODELS OF CAT-BUILT

THE PAYOFF FOR YOU: HIGHER PRODUCTION AT

Here are two new models of Cat-built Pipelayers designed to deliver even greater production at lower operating cost than the models they're replacing. Designed specifically for pipeline work, they're built to pay off in performance that no other units in their class can match.

Caterpillar's Project Paydirt sparked the improvements that account for their superiority. Major improvements include a new turbocharged 140 HP Engine, new lifetime lubricated rollers and idlers and new dry-type air cleaner. At the same time, many job-tested Caterpillar features have been retained.

As a result, there's more power, longer life and less maintenance—in short, *more profit* for you!

Get the complete facts about the new machines from your Caterpillar Dealer. There's a spot for each in your spread. Ask him to demonstrate. Say when and where—he'll be there! (See the great new No. 583, D8 and D7, too!)

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

FAST FACTS ABOUT THE NEW PIPELAYERS

	No. 572 Series D	MD7 7-roller frame
Lifting capacity (4-ft. overhang), lb.	86,000	54,200
Turbocharged engine, horsepower at sea level	140	140
Drive	Torque converter	Direct, oil clutch
Ground clearance, in.	19	15½
Total extendable counterweight, lb. (approx.)	10,900	8,600
Approximate shipping weight, lb.	58,500	35,800

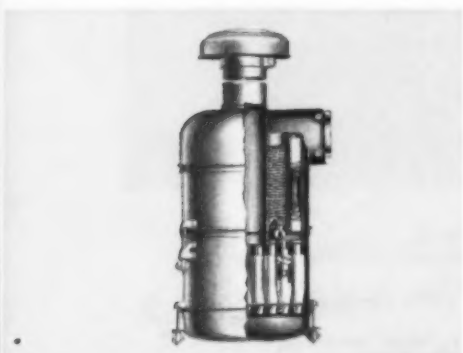
CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

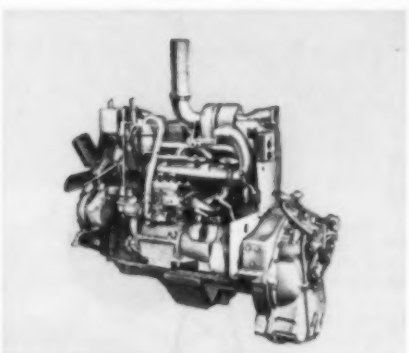
BORN OF RESEARCH
PROVED IN THE FIELD

PIPELAYERS FOR YOUR SPREAD

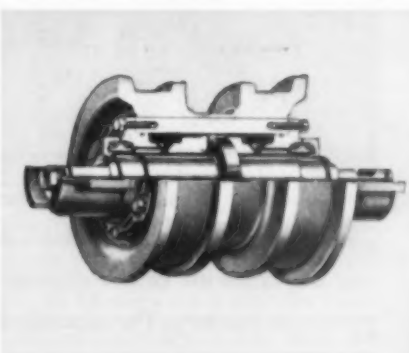
LOWER COST AND LONGER LIFE, LESS MAINTENANCE!



NEW DRY-TYPE AIR CLEANER. Here's still another major Caterpillar research development on these machines — the new dry-type air cleaner which removes at least 99.8% of all dirt from intake air during every service hour. Filter element can be cleaned and re-used. Cleaner can be serviced in 5 minutes. Payoff: longer engine life, greater economy, less maintenance.



NEW TURBOCHARGED ENGINE. The horsepower of these modern, heavy-duty pipelayers is up from 128 to 140 at the flywheel, an increase of 9%. Since the turbocharger uses waste energy from the engine exhaust to pack more air into the cylinders, over-all efficiency and fuel economy are substantially increased. Another payoff: faster response to load changes.

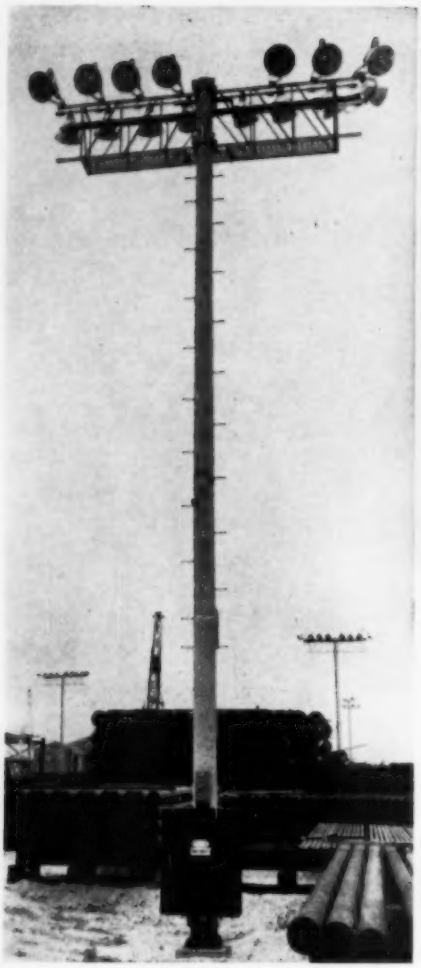


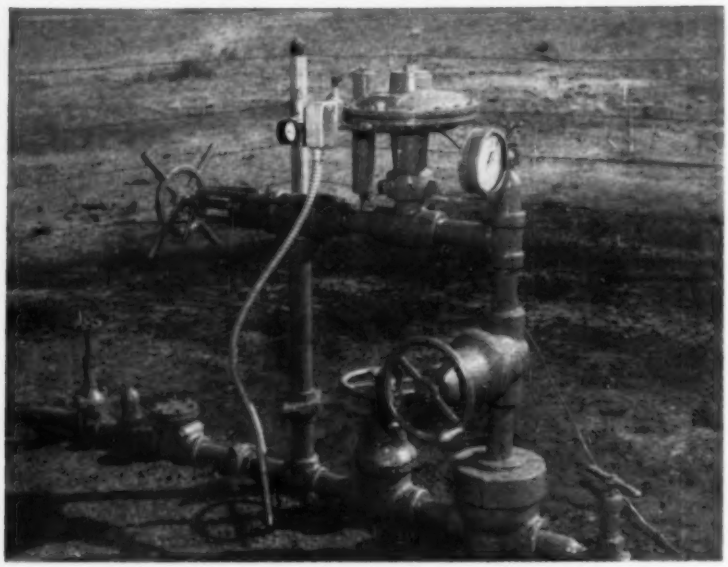
NEW LIFETIME LUBRICATED ROLLERS AND IDLERS. That's right — lifetime! In a major research breakthrough, Caterpillar has achieved track and carrier rollers and idlers that never require further lubrication until rebuilding. On-the-job roller lubrication is eliminated. Over-all payoff: greater economy and less maintenance than with ordinary rollers and idlers.

* ***PROJECT PAYDIRT:*** Caterpillar's multimillion-dollar research program — to meet the continuing challenge of the greatest pipeline construction era in history with the most productive machines ever developed.

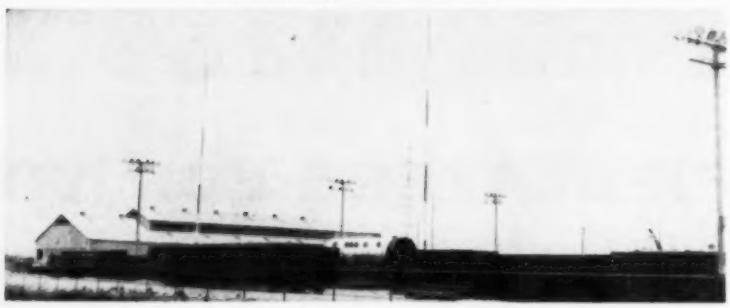
You can depend on purchased electric power for

AUXILIARIES





Electrically operated solenoid on flowing well with valve controlled by electric time-clock.



Lighting for oil company pipe storage yards and rail unloading areas.

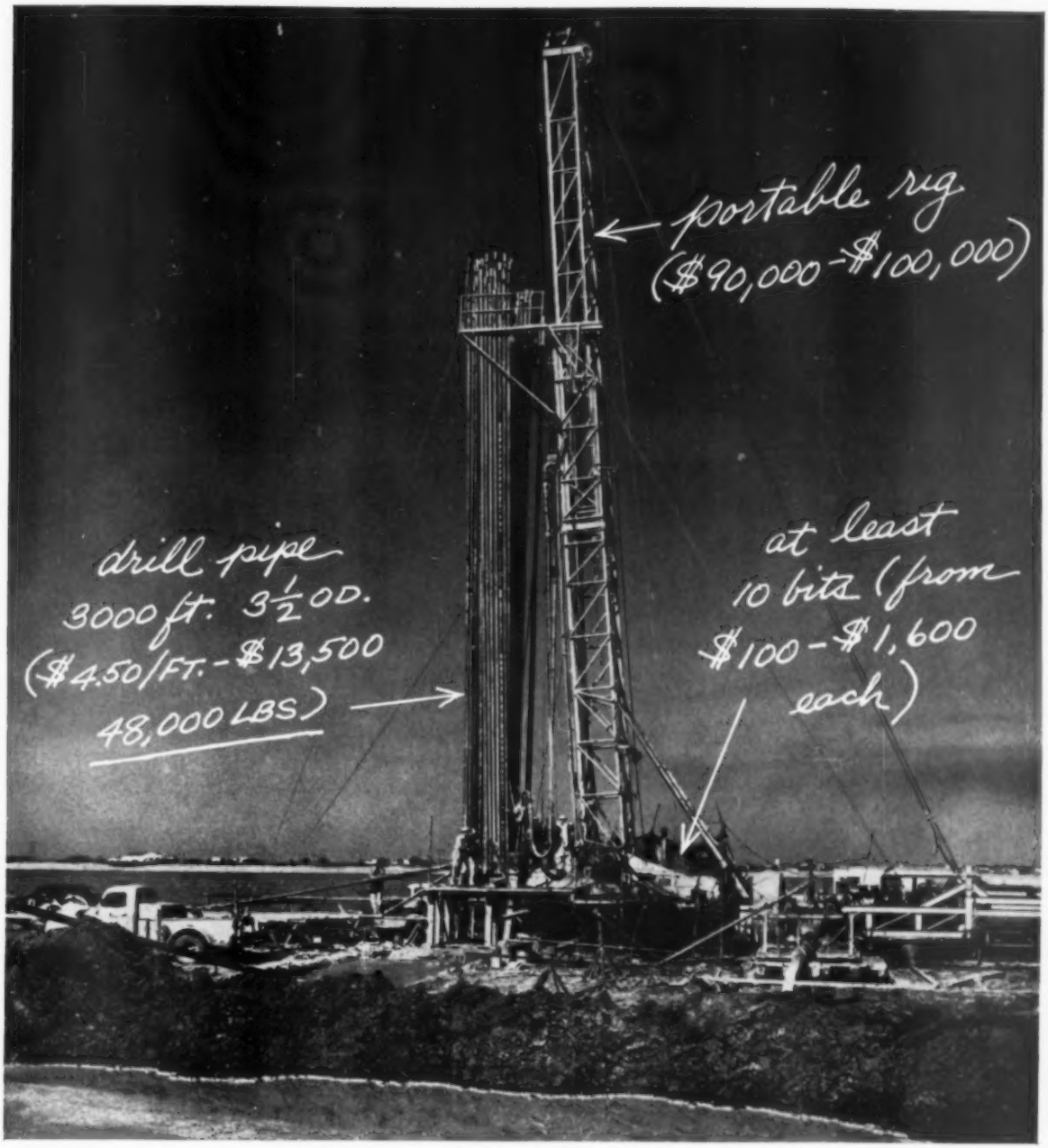
Typical of thousands of auxiliary applications of purchased electric power... the photographs above indicate the varied use of electricity in the petroleum industry. The dependability and economy of utility electric power is fast proving the answer to many problems in oil producing, transporting and refining. Contact your nearest utility electric power company for full cooperation.

Purchased Electric Power... saves money, manpower, maintenance, and serves you better automatically

Petroleum Electric Power Association

P.O. BOX 35006, DALLAS 35, TEXAS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



When you spend $90,000 for a drilling rig you've got to use the best rope available →

The best long-run, moneysaving rope. The high cost of portable drilling rigs excludes the "wise" buying of any rope below the quality level of Roebling Royal Blue. Anything less will cost you *more*, in replacements, delays, frustration.

Royal Blue is a product of America's oldest wire rope manufacturer. It is made from the toughest rope wire ever produced—Type 1105—extra high-strength improved plow steel. Preformed Royal Blue has a flexibility that curves around replacement costs and leaves them dormant. It is the strongest wire rope you can buy and use . . . for a long time.

You need exceptional resistance to shock, abrasion, fatigue and impact. You need around-the-clock ruggedness. Your Roebling distributor has what you need—Roebling Royal Blue. Get it and save. Wire Rope Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey, will send you details. Write.

ROEBLING

Branch Offices in Principal Cities • Subsidiary of The Colorado Fuel and Iron Corporation

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

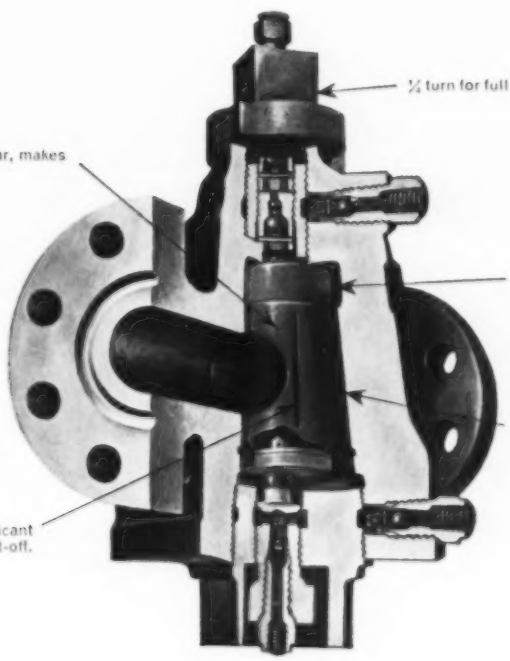
ROCKWELL-Nordstrom **VALVES**

Confidence

A parachute is worn with the hope that it will not be used, yet with the *confidence* that it will do the job if it's needed.

Some valves are like parachutes. On fire lines or emergency shut-offs, for example, they're the valves you never want to use. But they are the ones that must perform *perfectly* if the need arises. Most often you'll see Rockwell-Nordstrom lubricated plug valves in these "confidence" services because half a century of on-the-job proof has established one important fact: *they are valves you can depend on*. And it's this confidence on the tough services that has made them demanded so often on *every* service.

INSTANT, DEPENDABLE VALVE OPERATION


¼ turn for full opening or closure.
Lubricant stops wear, makes operation easy.
Even after months in one position, pressurized lubricant "cushions" plug for instant operation.
No exposed seats to wear and fail.
Sealdport® pressurized lubricant sealing assures *positive* shut-off.

Rockwell-Nordstrom is the original and world's most complete line of lubricated plug valves with sizes from ¾" to 36" and pressures to 15,000 lb. Available at leading oil field and industrial supply houses everywhere. For details, see your supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. If you live outside the U. S. A., write: Rockwell International Division, Pittsburgh 8, Pa.

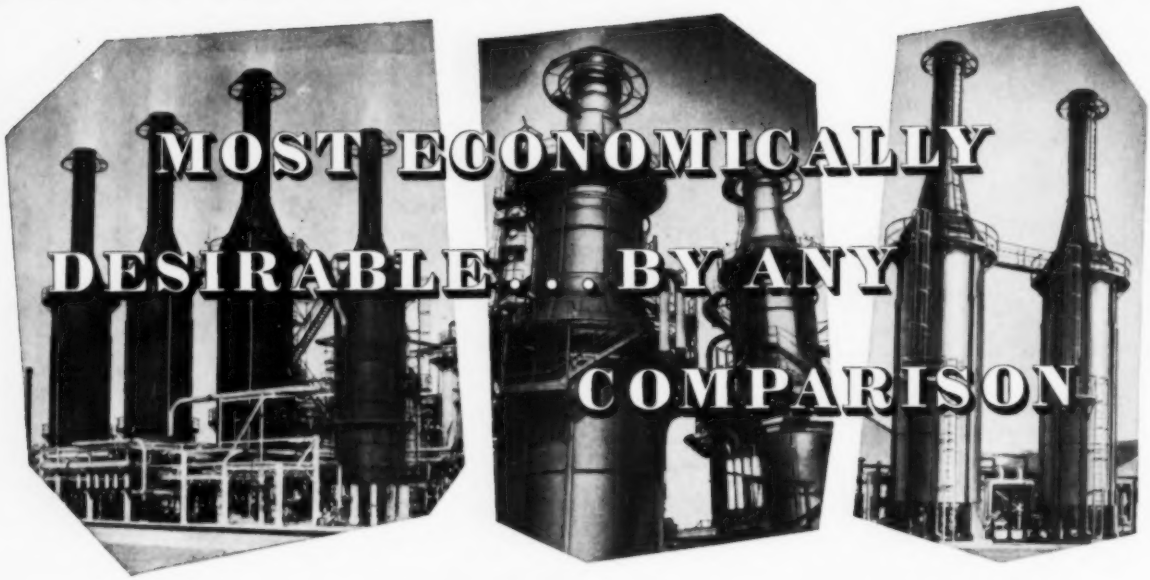
ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL

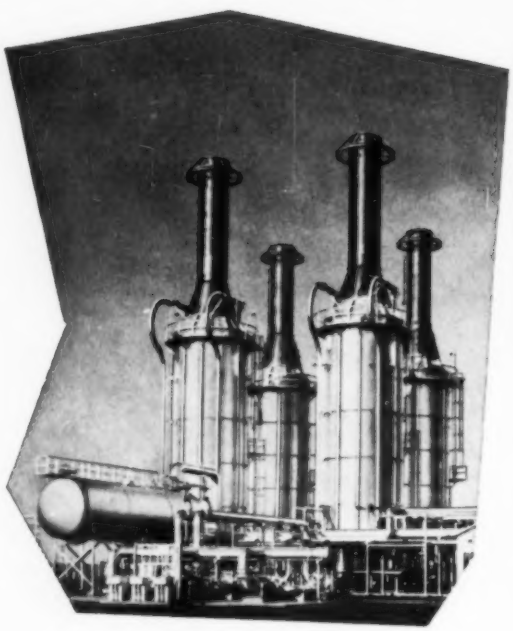
®Reg. T.M. Rockwell Manufacturing Company

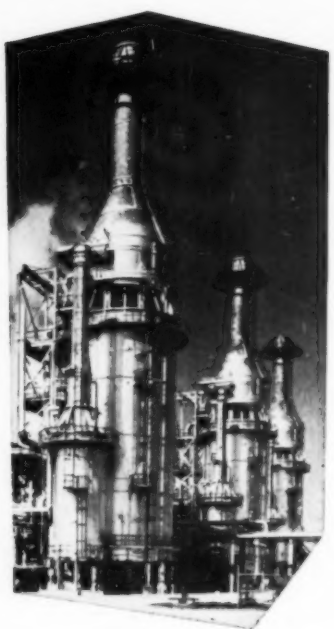
PETROCHEM-ISOFLOW FURNACES



MOST ECONOMICALLY DESIRABLE . . . BY ANY COMPARISON

in every country of the free world for every process heating requirement





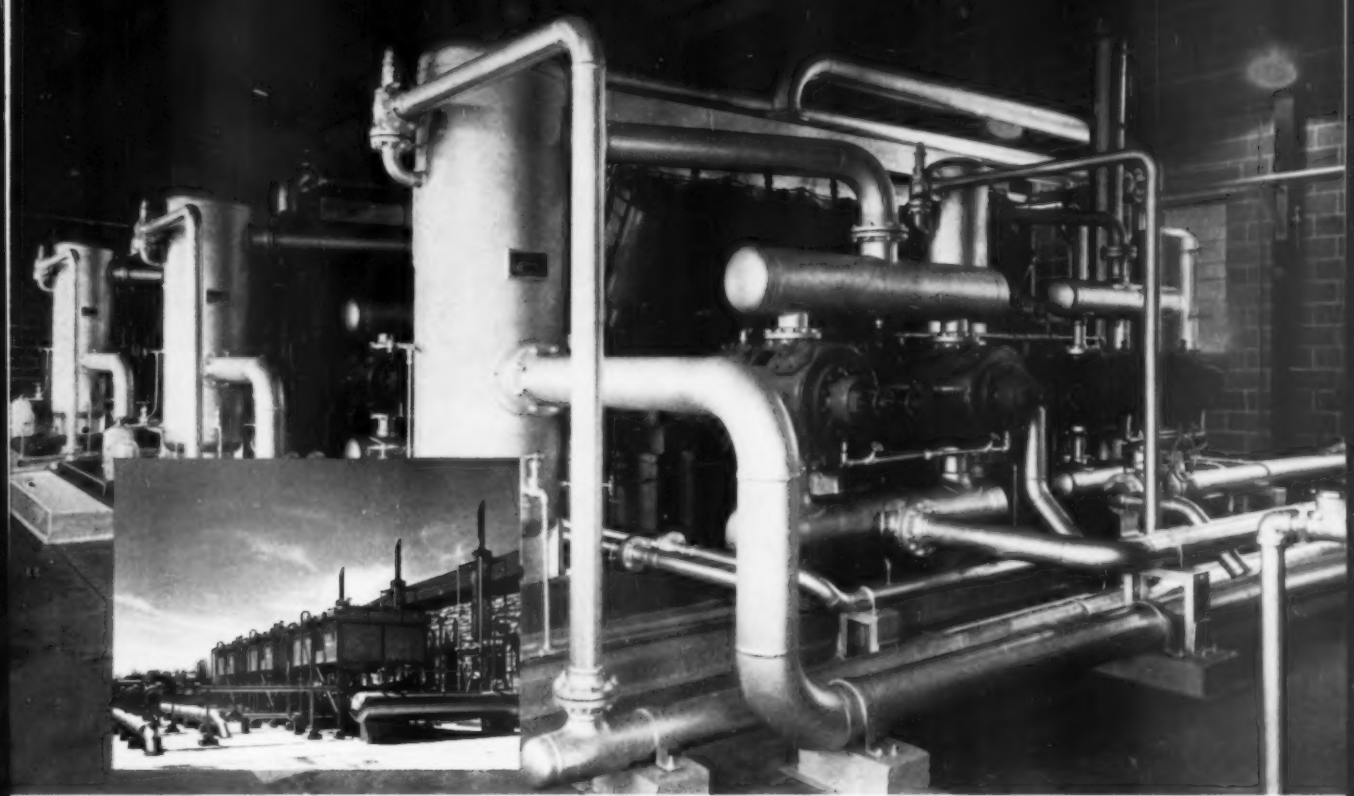
PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

REPRESENTATIVES: Faville-LeValley, Chicago • **Flagg, Brackett & Durgin,** Boston • **D. D. Foster,** Pittsburgh • **William H. Mason,** Tulsa • **Lester Oberholtz,** Los Angeles • **Combustion & Power Equipment Ltd.,** Montreal and Toronto • **Rawson-Haulihan Co.,** Houston • **Rawson Co.,** Baton Rouge • **Rittelmeyer,** Atlanta • **H. W. Severance,** Prospect, Ky. • **Turbex Equipment,** Narberth, Pa. • **G. M. Wallace,** Denver, El Paso & Salt Lake City **International Licensees and Representatives:** Birwelco Ltd., Birmingham, England • Fujinagata Shipbuilding Ltd., Osaka, Japan • Heurtey Italiana, S. P. A., Milan, Italy • Petrochem G. M. B. H., Dusseldorf, Germany • SETEA S.A., Buenos Aires, Argentina • Societe Anonyme Heurtey, Paris, France • Societe Anonyme Belge Heurtey, Liege, Belgium

BEAIRD-INGERSOLL-RAND Packaged Compressor Plant



Horizontal radiators are cooled by hydraulic motor driven fans powered by pumps V-belted to sheaves on the end of each engine crankshaft.

Laclede Gas Company's Gas Storage Project—equipped with three Beaird-Ingersoll-Rand 660 h.p. 12SVG packaged compressors. Units have Young radiators with gas, lubricating oil and engine water cooling sections. Other Beaird compressors from 120 to 660 h.p.

PACKAGED COMPRESSORS STORE WINTER'S RESERVE GAS SUPPLY FOR ST. LOUIS

IN ONE of the largest and most successful projects of its type, Laclede Gas Company of St. Louis is pumping billions of cubic feet of natural gas into sandstone that never held gas before. This additional supply will meet peak load demands enabling the company to heat additional thousands of St. Louis homes this winter.

Three Beaird-Ingersoll-Rand 660 h.p. 12SVG packaged compressors are taking up to 16 MMcfd, delivered by pipeline from Louisiana, compressing it through two stages from 50 to 125 psi. suction to 655 psi. discharge. The gas is injected down 1400-1500 foot wells into a natural sandstone reservoir bed.

Gas interstage and after cooling is provided in sections of the horizontal radiators mounted outside the compressor building. Use of electric motors to drive auxiliary equipment has been eliminated wherever possible. Pumps for engine cooling water, lubricating oil and radiator hydraulic fan motors are all driven off the compressor.

LOWEST COST PER HORSEPOWER INSTALLED

BEAIRD
another AMF product
PACKAGED COMPRESSOR PLANTS

Packaged Compressors are just one of the many products manufactured by Beaird for the petroleum and petrochemical industries. When you are in the market for new equipment or assistance in developing a specialized product . . . contact Beaird for a qualified appraisal or quotation.

THE J. B. BEAIRD COMPANY, INC.
Shreveport, Louisiana

A Subsidiary of American Machine & Foundry Company

SHREVEPORT, LOUISIANA • *Sales Offices: Dallas, Houston, Corpus Christi and Midland, Texas* • *New Orleans, Louisiana* • *Tulsa, Oklahoma* • *Denver, Colorado* *Los Angeles, California, and Cic. Ingersoll-Rand, Paris, France.*

BEAIRD INTERNATIONAL, INC.
SHREVEPORT, LOUISIANA • *Sales Offices: Calgary, Alberta, Canada* • *Caracas, Venezuela.*

"The tendency for governments to exert more and more control over business affairs affects the ability of all private investment to serve people and earn a proper return. Often such actions have results beyond those intended, to the detriment of investors, consumers, and free world prosperity and security."

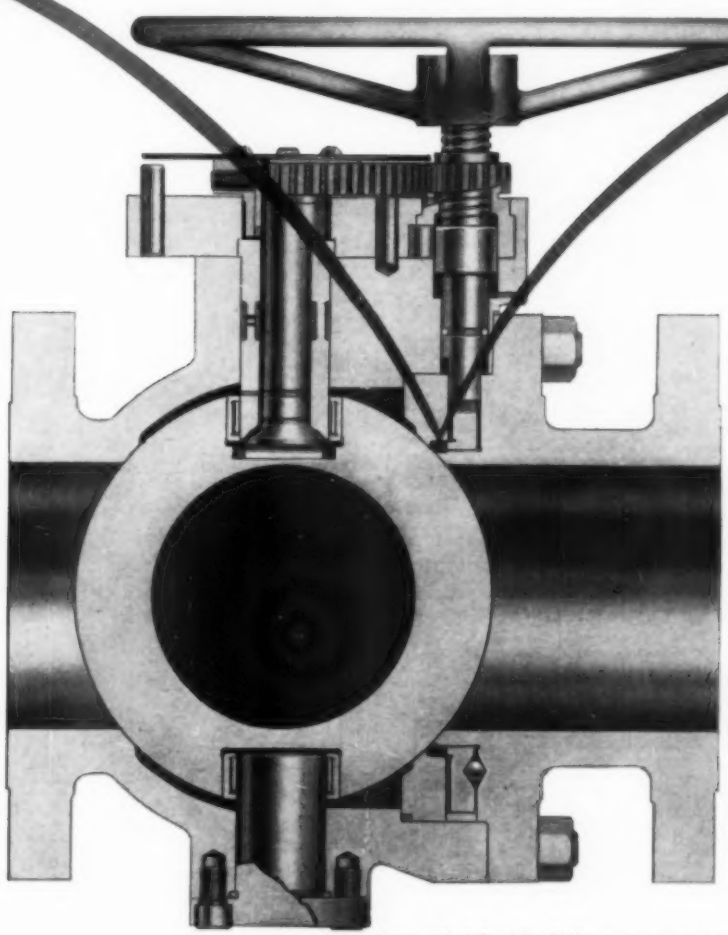
—*From the 1958 Annual Report*

Standard Oil Company (New Jersey)
and affiliated companies

ESSO

HYDRIL BALL PLUG Type "K" VALVES

COMPRESSIBLE PORT SEAL
provides
POSITIVE SHUTOFF



Hydril Ball Plug Valves achieve a positive seal against pressure from either direction because the fully enclosed packing ring is *mechanically pressed* tightly against the spherical plug and its seat after the valve is closed.

No other valve has this *controlled* port sealing feature.

SEEP-PROOF, BUBBLE PROOF. The fully confined packing ring is tightly squeezed against plug and seat so that it flows into surface imperfections, around sediment . . . even closes scratches that may occur on the sealing surfaces.

PORT SEAL RETRACTS for easy operation. The mechanical pressure against the port seal is released before plug rotation commences to eliminate seal ring wear and assure easy operation.

•

Write for catalog describing Hydril Ball Plug Valves in full detail.

Another dependable Hydril pressure-control product

HYDRIL COMPANY

714 W. Olympic Boulevard, Los Angeles 15, California

Sales offices: Bakersfield, Los Angeles, Ventura, California; Harvey, New Iberia, Louisiana; Youngstown Ohio; Oklahoma City, Tulsa, Oklahoma; Rochester, Pennsylvania; Corpus Christi, Dallas, Houston, Midland, Odessa, Texas; Casper, Wyoming; New York, New York; Calgary, Edmonton, Canada.

• News
• People

The Trade PARADE

ADDS FACILITIES. Chicago Bridge & Iron Company has announced plans to add a 100 by 500 ft building and a "pickling" facility to its plant near Houston, Texas. A CB&I spokesman said this construction would complete a $1,000,000 expansion program started 2 years ago. The new building will house the plant's fabricating and erecting equipment. The pickling facility will be used to remove excess mill scale from steel plates and shapes utilized in the fabrication of large capacity storage vessels and processing equipment.

OVERSEAS ACTIVITIES UNITED. A new division has been formed to unite all overseas activities of The Dayton Rubber Company, known as Dayton Rubber International. Headquarters will be in Dayton, Ohio. Richard D. Rosenberg will be responsible for all of the division's activities.

HALLIBURTON ADDS OTIS. Otis Engineering Co. has become a subsidiary of Halliburton Oil Well Cementing Co. Directors of both firms completed stock transfer in mid-July and Halliburton elected H. C. Otis, Otis' founder and chairman, to its board of directors. No changes are contemplated in Otis' present operations and policies, it was understood. All employees and officers are remaining with the new company. Founder Otis is chairman of the new Halliburton subsidiary. Robert H. McLemore remains as president and H. C. Otis Jr. as executive vice president. Another Texas company, Welex Jet Services of Fort Worth, was absorbed by Halliburton in 1957. Operated also as a subsidiary and now known as Welex, Inc., it has approximately 1000 employees in North and South America.

SHAWNEE MFG. ACQUIRED BY KOEHRING. The acquisition of the complete business of the Shawnee Manufacturing Company, Inc., of Topeka, Kansas, was recently announced by Koehring Company. Shawnee manufactures backhoes, loaders, brooms, scrapers, rear blades, and other attachments for wheel type utility tractors and will operate as part of Koehring's Parsons Division of Newton, Iowa, which manufactures trench digging equipment used in pipelining by utilities, municipalities and in allied fields.

CHANGES CORPORATE NAME. The stockholders of Perforating Guns Atlas Corporation of Houston, Texas, authorized a change of the company's name to Pan Geo Atlas Corp.

WAREHOUSE IN OKLAHOMA CITY. Harbison-Fischer Mfg. Co. has opened its 10th branch warehouse—at 2734 High St. in Oklahoma City. The new facility will be a stocking point for the company's complete line of sub-surface pumps and related production equipment.

SPECTROMETERS IN ORBIT. Consolidated Systems Corp., a wholly-owned subsidiary of Consolidated Electrodynamics Corp., has received a $98,600 contract from the Goddard Space Flight Center of the National Aeronautics and Space Administration for development of miniature mass spectrometers that will be placed in orbit within a satellite to analyze and measure the elements of the exosphere, the uppermost region of the atmosphere.

Telemetered data from the analytical instruments is expected to give scientists accurate information on makeup of the exosphere in a region between 150 and 600 miles above the earth.

The satellite, about 35 in. in diam will be launched in 1961 with two of the mass spectrometers aboard, according to the NASA. Several of the instruments will be tested in rocket firings prior to the launching. Project chief at CSC will be Larry G. Hall.

FORMS NEW PAINT GROUP. Organizational changes designed for more effective handling of its expanding interests in raw materials, particularly in styrene-butadiene latexes, for the paint industry are announced by The Dow Chemical Company. M. C. Carpenter has been advanced to manager of the Paint Industry Group in coatings technical service (CTS). The new trade sales section, under the direction of James L. Huffman, will handle CTS activities on latexes and resinous and oleoresinous products going to the trade sales area. The industrial section, also new, is in charge of R. B. Drubel. The testing section will continue its work under R. H. Lalk as section head.

PROCESS ENGINEERS

If you are a Process Engineer with at least 5 years experience in one of the following: Gas Plants, Gas Plant Design, Gas Treating, Sulfur Plants, or general refinery process design.

WORK IN SOUTHERN CALIFORNIA

GOOD STARTING SALARY

EXCELLENT WORKING CONDITIONS

PROFESSIONAL ACHIEVEMENT

Airmail resume. Include salary requested and when you will be available, to:

R. J. NUSSELL
PARSONS
617 West 7th St., Room 730
Los Angeles 17, California

OIL FIELD EQUIPMENT

Is paraffin in the well formation, tubing and flow lines a problem to you? We manufacture truck-mounted, LPG-fired, 2" coil oil heating units to pump hot oil down the well to remove paraffin and waxes and to treat oil in storage tanks. Capacity to 4 BPM. *Call or write your requirements for a quotation:* Southwest Welding Co., L. M. Key, Owner, P. O. Box 305, Wichita Falls, Texas. Telephone 322-2022.

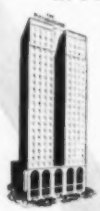
WANTED: RESEARCH ENGINEER

Research engineer with degree in petroleum, chemical, or mechanical engineering for expanding work on problems in gas transmission and allied fields. Unusual opportunity for professional development. Industry-wide contacts. Educational opportunities. Competitive salary. Write or call **R. T. Ellington, Institute of Gas Technology, Technology Center, Chicago 16, Illinois.**

CHIEF ENGINEER
PRODUCTS TERMINALS AND PIPELINES

WANTED: Experienced engineer capable of establishing and supervising engineering department for construction of petroleum products terminals and products pipelines, including complete design, issuance of quotation requests and material authorizations, supervision of construction engineers and approval of subcontractors' designs. Must be able to provide preliminary design rapidly and estimate construction costs accurately enough to provide basis for competitive bids. Must have field experience in design and construction of terminals and pipeline including hydraulic, electrical, civil and mechanical design, and have mental capability of working for non-engineer. Will be located in Southwest. Some travel required. Will guarantee three years employment $20,000 year, if ability proven by performance. *Send resume including references to* **Box 210, The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.**

Your Choice for Convenience in PITTSBURGH



Hotel Pittsburgher

Right in the heart of the Golden Triangle 400 outside rooms with TV and every comfort of modern hotel design. General Forbes Lounge and Dining Room . . Air Conditioning. Airport Limousine and Taxi Service.

Forbes Avenue Below Grant

ATlantic 1-6970

Jacktown Motor Hotel

The very finest accommodations. 60 air-conditioned rooms with TV, telephone, combination tile baths. Excellent dining room. Facilities for group parties 15 to 500.

Route 30 Irwin, Pa.
1 mile West of Irwin Interchange

UNderhill 3-2100

Hotel Pittsburgher Motel

KNOTT K HOTELS

Opposite Greater Pittsburgh Airport on beautiful Airport Parkway West. 56 luxurious air-conditioned rooms with tile bath, TV, private phone. Courtesy car to and from airport.

AMherst 4-5152

Joseph I. Dudds, Gen. Mgr.

*Teletype Service. For immediate confirmation of reservations at no charge . . telephone any Knott Hotel or teletype PG 29

Trade Parade

BOLIVIAN DISTRIBUTOR. Equipo Petrolero Ltda. of La Paz, Bolivia has been named exclusive distributor of Gardner-Denver Company oil field equipment in that country. Headed by Alberto Vasquez, formerly with Y.P.F. Bolivia, the new distributorship will coordinate sales and services in conjunction with Gardner-Denver specialists in Chile and Peru. Expanded activity of Bolivia's petroleum industry is responsible for the increase in South American outlets, Gardner-Denver executives said.

WESTERN SALES OFFICE OPENED. Opening of a Western regional sales office in Portland, Oregon, and the appointment of E. L. Rhoads as western manager of aliphatic nitrogen derivatives sales is announced by the Armour Industrial Chemical Company, of Chicago. Rhoads will be responsible for sales in Oregon, Washington, Idaho and Nevada. He will also act as technical coordinator for the Armour sales agent, Paul W. Wood Company of Los Angeles and San Francisco, who cover the states of California and Arziona.

NEW GROUPING. Formation of the Armour Industrial Chemical Company, a new grouping, is announced by Armour and Company. The new company will be under the direction of M. E. Lewis, general manager. Armour Industrial Chemical Company has moved its management and sales personnel to new and larger quarters at 110 N. Wacker Dr., Chicago. Armour Industrial Chemical comprises the fatty acids, fatty nitrogen derivatives and the ammonia divisions. R. S. Passmore will continue as ammonia division manager and P. W. Fulford will remain in charge of ammonia sales. B. W. Graham continues as director of sales for the fatty acid and derivatives division. The chemical research division remains under Dr. M. R. McCorkle and the McCook, Ill., chemical plant under C. E. Lang.

AEROTEC MERGER. Aerotec Industries, Inc., announced the merger of the Prat-Daniel Corporation, South Norwalk, Conn., The Aerotec Corporation and The Thermix Corporation of Greenwich, Conn., and The Aerotherm Corporation of Bantam, Conn. Executive offices of the new corporation will be in Greenwich. The following officers of the new corporation took office: Louis C. Whiton, chairman; John E. Watson, president; Jacques G. Mejean, executive vice president and treasurer.

DISTRIBUTOR NAMED. An association with the Valdura Division of American Marietta Co., of Chicago, has been announced by Maloney-Crawford Tank and Manufacturing Co. of Tulsa. The affiliation includes the distributorship of Val-Chem products and protective coatings, including the entire range of phenolics, vinyls, epons, chlorinated rubber and alkyds. It also means that Maloney-Crawford will work closely with the large laboratories and personnel of the Valdura Division of American Marietta.

ADDITIONAL PLANT FACILITY. Construction of an additional plant facility at its Wellsville, N. Y. site was announced by The Air Preheater Corporation. The new 40-ft high building will have 32,000 sq ft of floor area. It is being constructed in an 80 ft by 400 ft area between the company's Plant 2 and 3. Air Preheater plans to use the new facility as materials storage for the two adjoining plants. It will be adapted to manufacturing operations when production increases demand it.

ACQUIRES INDIANAPOLIS FIRM. American Hoist & Derrick Company has acquired the firm of Hetherington & Berner, manufacturers of stationary and portable asphalt plants and paving machinery. Donald R. Berner, Hetherington & Berner vice president, will become general manager of the new wholly owned subsidiary and that both Indianapolis plants, employing about 280 people, will continue to operate under the Hetherington & Berner name.

DRILL DISTRIBUTOR IN 4-STATE AREA. Union Pipe & Supply Co. following its merger with Cable Tool Supply Co. has been appointed a distributor for the complete line of water and oil well drills and parts and tools manufactured by Bucyrus-Erie Co. The new team will cover a 4-state territory — Western Kentucky; eastern Tennessee; southern Indiana and southern Illinois. This area was previously served by Cable Tool.

MASTS & DERRICKS DISTRIBUTOR. Baash-Ross Division of Joy Manufacturing Company has been named domestic distributor for Derrick String-a-lite assemblies for masts and derricks. This product will be available exclusively through oil field supply stores. Manufacturing will continue to be done by the electrical products division of Joy Manufacturing Company in St. Louis.

CONTRACT AWARDED TO B&W. The Babcock & Wilcox Company reported the receipt of a contract for more than $1.5-million to manufacture and install a boiler for the Madison, Wis., Gas & Electric Company.

Officials of Babcock & Wilcox's Chicago district sales office said that the boiler, which is scheduled to go into operation at the utility's Blount Street Station during the summer of 1961, is a duplicate of a B&W-manufactured unit which went on-line there in 1957.

STUDY OF WEATHER CONDITIONS. A broad-scale, long-range study of weather conditions as they may affect air travel during the next 15 years of the jet age will be undertaken by Borg-Warner Corporation under a contract awarded the company by the Federal Aviation Agency of the United States Government. The FAA foresees a greatly increased volume of air traffic, spectacularly higher speeds — perhaps 1800 mph transports, and growing complexity of air traffic control. These developments will create new demands for weather information services along with improved accuracy of the information.

EXCLUSIVE REPRESENTATIVE. Brown Oil Tools, Inc. has announced the appointment of Hugh J. Gransaull and Company, Ltd., as the exclusive representative in Trinidad, B.W.I., for Brown equipment.

C-R-C DISTRIBUTES FOR J-M. Crutcher-Rolfs-Cummings, Inc., has been appointed distributor of the complete line of Johns-Manville fiber glass pipe wrap products. C-R-C has been a J-M distributor for 3 years handling asbestos pipeline felts.

BS&B REPRESENTATIVE. The Hawkins Company, 201 Builders Building, Charlotte 1, North Carolina, has been appointed manufacturer's representative for BS&B Controls, safety head and tank vents in North and South Carolina.

AMERICAN®

PRESSURE and TEMPERATURE RECORDERS

American® single and two-pen *Pressure Recorders* for pressures from 30 inches vacuum to 10,000 psi.

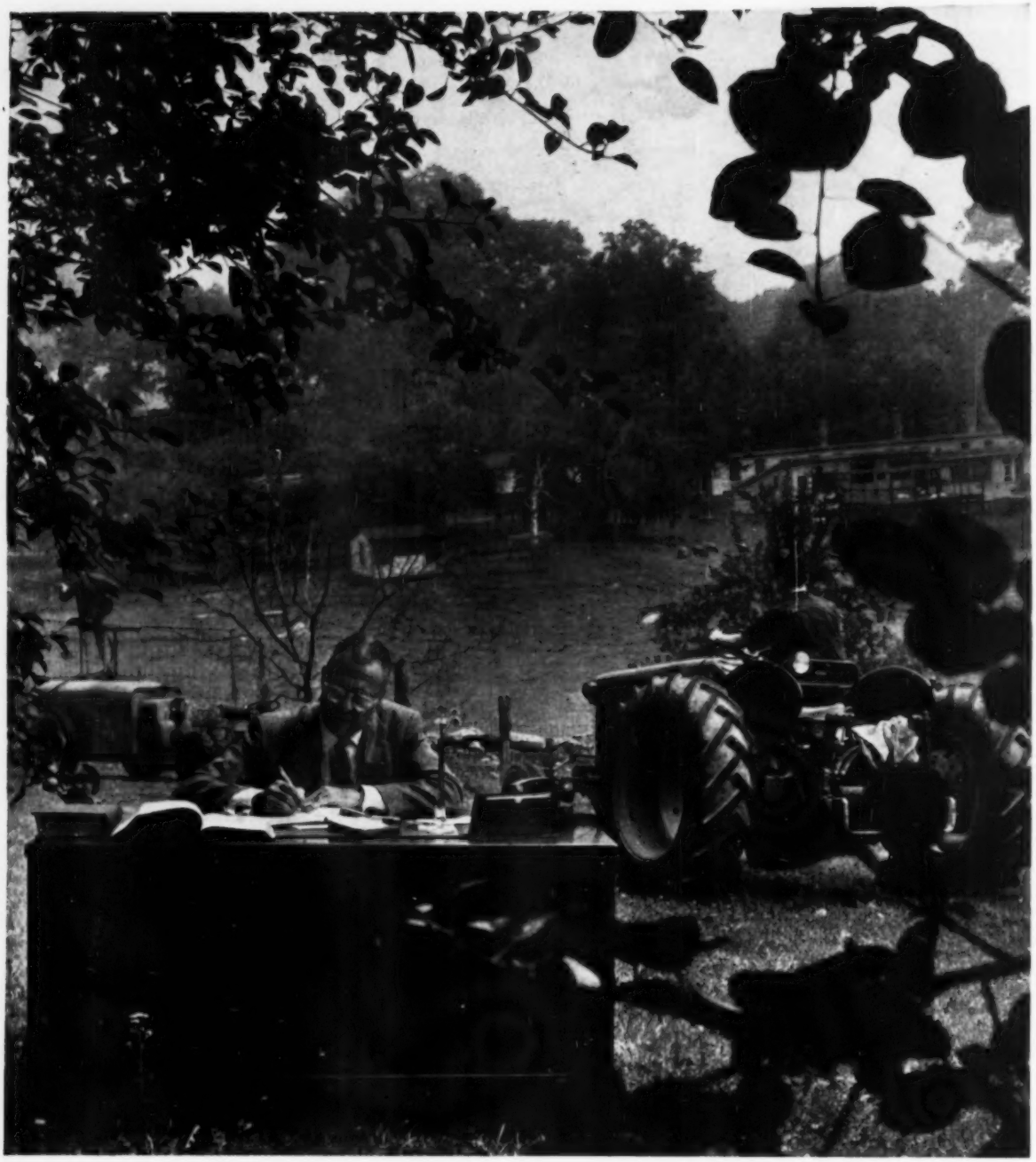
- Pressure elements individually calibrated over full range.
- Variety of chart drives available.
- Helical elements of different ranges are interchangeable.
- Stainless steel pen arms with span and linearity adjustments.
- Aluminum dust and moisture-proof case.

American® *Temperature Recorders* for an accurate record of flowing temperatures.

- No ambient temperature errors.
- High sensitivity and torque — fast speed of response.
- Standard 0-150°F. range. Other ranges available by request.
- 24-hour mechanical or 110-v. 60-cy. electric chart drives.

Ask for Bulletins 400 and 408

AMERICAN®
METER COMPANY
INCORPORATED (ESTABLISHED 1836)
General Offices: Philadelphia 18, Pa.
Sales Offices in Principal Cities



How an oilman at his desk protects the fruit of the land.

He is part farmer, part chemist, all oilman. He knows how to use oil-based insecticides to help keep farm produce free from destruction by aphids, nematodes, grasshoppers, mites and other hungry insects. He knows how important oil is to today's highly mechanized farms. He knows—and so do you. The next time you hear somebody speak out against oil—tell him you're an oilman and proud of it. And tell him why.

SHELL OIL COMPANY

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

International Harvester Company. Martin L. Case was appointed assistant manager of the Melrose Park, Ill., works. Case, general superintendent at Melrose Park, succeeds Earl P. Dacy, named manufacturing manager of International Harvester's Australian subsidiary.

Johnston Testers, Inc. T. W. Cole was promoted Rocky Mountain area manager with headquarters in Casper, Wyoming. He formerly was named senior salesman and then advanced to assistant area manager with headquarters in Casper.

Koehring Company. J. E. Chadwick was appointed to head a new department to integrate sales to national and fleet buyers, to be part of central office marketing activities.

Liberty Manufacturing Company of Texas. Jack D. Gale was appointed sales manager.

Lucey Products Corporation. R. A. "Bob" Pitzer has joined the company and will act as special representative in the Gulf Coast Area, with headquarters in Houston.

Lone Star Steel Company. Claude L. Doughman Jr. has joined the steel pipe sales division and will work with district sales manager Robert Reed in the Houston office.

Lane-Wells Company, a division of **Dresser Industries, Inc.** John C. Stick Jr. was named assistant manager of logging services. He will headquarter in Houston.

Minneapolis-Honeywell Regulator Co. William F. Newbold was appointed director of research for the Brown Instruments Division. He succeeds Walter P. Wills, director since 1955, who is named technical advisor to the director of engineering, a new post.

Motorola Inc. Carl Pehlke has been named assistant to the manager of the microwave department for Motorola's communications & industrial electronics division.

Otis Engineering Corporation. Raymond Herbert was named division manager in Houma, La., and Harold Watson is the new manager for the firm's Belle Chasse, La., division. Donald M. Taylor Jr., Dallas, was also appointed sales manager for the firm's newly-marketed Otis-Maihak bottom hole pressure and temperature recording instruments.

George Roach, formerly of New Iberia, La. was assigned to the New Orleans and Belle Chasse area as a sales engineer. Assigned to New Iberia as sales engineers are Tom Holleman and James Barnes. Holleman was formerly a salesman in the company's Houma branch and Barnes was salesman-in-charge of the company's Farmington branch. George T. Strong, former salesman-in-charge for the firm's Perryton, Texas branch, was transferred to Corpus Christi as a sales engineer. Strong previously was assigned to Otis Falfurrias, Odessa, and Farmington offices. Ivy Kirkland was appointed a sales engineer in Houma, and Joseph Morrison as a gas lift sales engineer in the New Iberia division.

Oil Field Sales & Service, S. A., subsidiary of U. S. Industries, Inc. Bill Richards, Richard Roman and Mitch Breedlove were named district managers and Grady Rodgers general manager of its wire line service.

Babcock & Wilcox. George W. Kross Jr. was promoted to assistant manager of tubing operations at the tubular products division, Beaver Falls, Pa. plant. G. E. Pletz succeeds Kross as superintendent of the division's Keystone Street plant in Alliance, Ohio. Robert E. Halloran was named Pacific Coast sales manager. He will make his headquarters at the Los Angeles district sales office and succeeds H. F. Lefferty, who is retiring. Thomas W. Wright is named assistant manager of the New York district sales office.

In the boiler division Ralph K. Behr was named manager of the New York district sales office. He succeeds Nicholas J. Connor, who has been appointed a sales consultant.

Replacing Behr as manager of the division's Boston district sales office is Gerald S. White, former sales engineer in Boston. Robert A. Barr was appointed general manager of the refractories division. He formerly was assistant general manager of the refractories division of The Carborundum Company.

Hostawax Company. Nicolaas C. Van Vonno was named president of the recently formed division of Hostachem Corporation.

Garrett Oil Tools, division of U.S. Industries, Inc. K. J. Walker was named manager of South American sales. Walker has served with Garrett since 1952, and has been manager of relief valves sales since 1955.

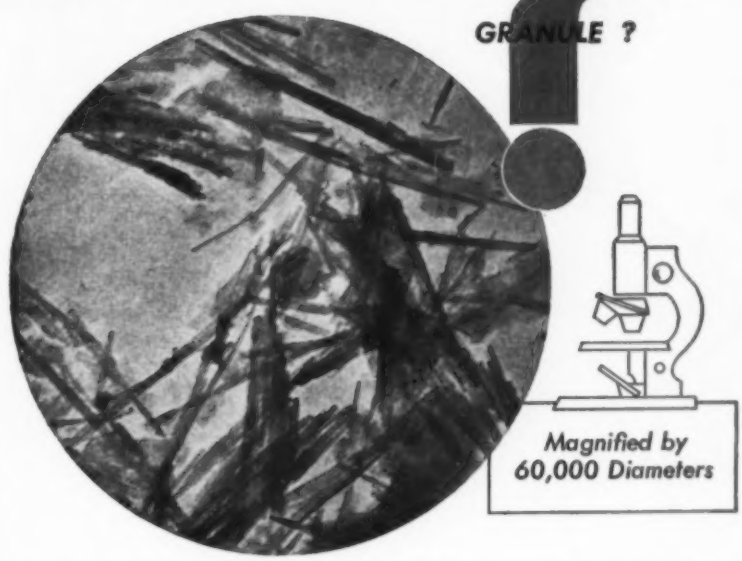
Graver Tank & Mfg. Co. Henry H. Hemenway was appointed director of research and engineering.

Jones & Laughlin Supply Division. J. R. Johnston was named assistant treasurer, J & L Steel Corp., and credit manager, J & L Supply. He succeeds P. R. Warner who recently retired. E. H. Moores succeeds Johnston as attorney.

EVER LOOK INSIDE A

Florex ?

GRANULE ?



The fibrous nature of Florida Fullers Earth, commercially available as Florex, reveals each unit consisting of about 2200 molecules in a bundle, providing ready selectivity in adsorption of color and contamination from organic and inorganic liquids and gases.

Florex quality means specially processed fullers earth giving maximum surface area and adsorption efficiency. Florex is unequalled in high quality or low cost for processes involving the use of highly active clay for sweetening light distillates, dehydration, desulfurization, and polymerization.

Standard meshes from 2/4 to 200/up and our experienced adsorption specialists are available to help you solve complex laboratory or production problems.

FLORIDIN COMPANY

Adsorbents
Desiccants
Diluents

Dept. D P.O. Box 989, Tallahasee, Florida

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Trade Parade

Wolverine Tube. Harold A. Harty, advertising and sales promotion manager was elected to chairman of the board of the National Industrial Advertisers Association.

Cameron Iron Works Inc. W. Roy Davis, formerly sales manager of the valve and oil tool division, was named manager of the pressure control equipment division, and W. L. Reynolds to sales manager of the division. R. F. Farmer and I. M. Baker were promoted to domestic-international executive sales assistants.

Continental-Emsco Company. Gary K. Ashmead was appointed district manager to supervise a newly formed district that is comprised of the Harvey, Houma and Venice field stores and New Orleans city sales office. William G. Sharp was named manager, export division, New York City, and JoEarl Morris manager, Continental-Emsco Company C. A., Caracas, Venezuela.

J. R. Bechtold and Lee Drake were named to Continental-Emsco's newly formed special projects and services division. Both men have been named to the position of assistant to the vice president. Charles Spitzfaden was named general manager of sales-non tubular and J. A. Whitesides to manager of drilling equipment sales department.

Barrett Division, Allied Chemical Corporation. John W. Bruce Jr., has joined the company as marketing manager, protective products and adhesives. Previously he was sales manager with Rubber and Asbestos Corp.

ARCCO
ARCCO CANNON
NEVER-DRY PEN
Writes for Months
REPLACES OTHER MAKES • USES REGULAR INKS
Regardless of pulsations or other causes of ink failures this Never-Dry Pen will make clean and complete records.
CHECK THESE EIGHT FEATURES
1. Always a continuous flow. No unrecorded records.
2. Holds sufficient ink for several months recording.
3. Constant weight for more accurate measurement.
4. Always clean, uniform records due to uniform flow.
5. No ink slopping or dripping in meter cases or on floor.
6. Uses regular recording inks or fast drying inks.
7. Stainless steel assures long and trouble-free service.
8. Used on practically any type of recording instrument.
Now made in 5 sizes. When ordering, specify make and type of recording instrument. Send for Bulletin 110-R2
$6.90 Each Net
Send for Quantity Prices
AMERICAN
RECORDING CHART COMPANY
7142 East Condor Street, Los Angeles 22, California
AD NO. 108
SEND FOR BULLETIN No. 110-R2

Curtiss-Wright Corporation. Clyde C. Williams was appointed general sales manager for the Utica division.

Crane Co. Wesley A. Songer was elected executive vice president. Joseph A. Donahue has been named manager of sales promotion. Donahue will be responsible for advertising-sales promotion activities along with catalogs and commercial research.

Clark Bros. Co. Z. B. Deer Jr. was appointed sales engineer in the Texas-Oklahoma Panhandle area.

Consolidated Electrodynamics Corporation. Franklin H. Donnell was elected senior vice president, finance. Clinton R. Stevenson, partner in the Los Angeles law firm of Watkins, Lund & Peck, was elected to the board of directors.

William Kneen was appointed chief project engineer, analytical & control instrument division. S. R. Wyzenbeek Jr., is manager of the Palo Alto district sales office.

Donald E. Stocking was named eastern regional manager. Succeeding Max Garber, recently named director of marketing for the company's Rochester division. Howard B. Lewis is chief engineer of the Transducer Division, and Frank A. Smith, manager of the Atlanta, Ga., district sales office. Smith succeeds Vincent M. Meagher Jr., who was recently named CEC marketing manager for transducer products.

Cooper-Bessemer. Donald L. Reed was appointed manager, packaged compressor sales. Harold G. Blassey was named to its New York domestic branch office.

E. D. Van Fossen and R. L. Moore were elevated to division managerial posts with Van Fossen as western district manager and Moore as eastern district manager. Roy W. P. Johnson was appointed district manager.

Dowell Division of The Dow Chemical Company. C. E. Mangold and W. N. Estel were named assistant general managers.

R. S. Ousterhout, assistant general sales manager, is being transferred to Dallas to supervise the Dallas-Fort Worth sales offices. C. R. Olson, who has been in the Dallas office since 1955, will move to the Calgary, Alberta head office of Dowell of Canada Ltd. W. C. Atkin is transferring from Calgary to Dowell's general office in Tulsa where he will join the industrial sales department.

Dayton Industrial Products Company, division of Dayton Rubber Company. Joseph A. Conlon was named marketing manager.

De Laval Steam Turbine Co. Paul S. Nurko was appointed works manager. Before this promotion he was general superintendent, manufacturing division.

Daniel Orifice Fitting Co. Herbert H. Hodgeman has joined the company as valve design engineer.

Dresser Manufacturing Division, Dresser Industries Inc. Theodore A. Short was appointed sales promotion manager for original equipment.

Dow Chemical Company. Daniel Chapin, formerly with the sales staff of the Cincinnati office, was advanced to a new post as assistant to the manager, Detroit office.

Empire Geophysical, Inc. J. R. Hunt was appointed a director. He is vice president and regional manager in Denver. Also announced was the election of John Horgan of the J. H. Whitney Co. of New York City as a director.

Trade Parade

Garrett Oil Tools, division of U. S. Industries, Inc. C. M. Peters was named vice president — sales engineering. He will be in charge of Garrett's operations in Europe and the Sterling currency areas. He has held the position of vice president-engineering since 1956. V. B. Scott was named manager — product development. B. A. Abercrombie moved to the position of administrative engineer — product testing and evaluation, and F. L. Magoon to the position of administrative engineer — research and development.

ACF Industries, Inc. H. Ben Young, director of engineering and research at W-K-M since 1956, was elected a staff vice president of the parent company, ACF Industries.

Allis-Chalmers Manufacturing Company. George A. Saar was named assistant to J. L. Singleton, vice president of the industries group. Saar has been manager of the electrical department at Norwood (Ohio) Works.

Armour Industrial Chemical Company. J. E. Haughn was named sales representative with headquarters at Houston, Tex. Haughn succeeds J. P. Badman recently appointed manager of highway construction chemicals.

American Meter Company. Harold W. Wahl is manager of Southwest Division. He has been manager of the Southern division of Westcott & Greis, Inc., an American Meter subsidiary recently incorporated into the company's Southwest division.

American Iron and Machine Works Company. J. S. "Dutch" George was appointed special representative with headquarters and territory in Tulsa.

Baldwin-Lima-Hamilton Corporation. Frederick A. Fielder was elected vice president and general manager of the Loewy-Hydropress Division, New York City.

Burndy Corporation. Lawrence M. Lyons was named production manager of the utility-industrial division to supervise all manufacturing at the division's plants in New York City and Connecticut.

Bonney Forge & Tool Works. Joseph M. Potts was elected president. Prior to assuming his new duties, Potts served as vice president and general manager of its Allentown operation. William M. Jackson and Charles A. Boz will continue as assistant managers in Allentown and Alliance respectively.

Bethlehem Steel Company — Supply Division. George L. Reid was appointed administrative assistant to J. V. Spalding, general manager of sales. He will act as a liaison between sales and manufacturing departments. C. R. McNair was named sales manager, production equipment, and F. C. Underwood was made sales manager, secondary recovery equipment.

Borg-Warner Corporation. S. J. Becker was named vice president and chief engineer of the spring division.

Baroid Division National Lead Company. J. K. Meagher has transferred from Dallas to Houston as sales representative in the Lower Texas Gulf Coast area. Replacing him in Dallas will be N. S. Wood, who has previously worked with Baroid at Calgary, Alberta, Canada.

Black, Sivalls & Bryson, Inc. Arvid H. Edwards was appointed advertising manager, formerly serving as assistant advertising manager. John H. Boetjer has been named advertising supervisor, controls division; he has been supervisor of publications. J. D. Hughes will serve as advertising supervisor, steel products division, moving up from the publications section of the department.

Pacific Pumps, Inc. A. George Seelke Jr. becomes manager of the Atlantic, Georgia district consisting of North Carolina, South Carolina, Georgia, Florida, Alabama, and Tennessee. New district manager for centrifugal pump sales for Southern California, Southern Nevada and Arizona, is Donald G. Jensen. Elton L. (Lee) Watts is the new district manager for centrifugal pump sales in charge of the San Francisco territory consisting of Northern California, Washington, Oregon, Idaho, Utah, and Northern Nevada.

Rockwell Manufacturing Company. Harold O. Proske, director of sales aids and training, was named branch manager, Shreveport, La., office of the meter and valve division.

SKF Industries, Inc. Henry D. Hineman was appointed field engineer Pittsburgh district sales office. He was formerly a senior regional engineer with SKF central sales region.

A. O. Smith Corporation. Robert N. Stime was named assistant director of merchandising and Edward A. Lukowski named group merchandising manager, to succeed Frank Kluck, resigned.

Seismograph Service Corporation. Joseph A. Keeling, former supervisor, was named manager of SSC of Argentina.

Texas Instruments, Inc. E. O. Vetter, an assistant vice president, was elected a vice president. C. J. Thomsen, vice president and division manager of the Metals & Controls division, will resume the position of vice president, control and finance, which he held prior to his present assignment.

Thompson Ramo Wooldridge Inc. Thomas A. Johnston was named chief of a new space power systems group in the research and engineering requirements department of the tapco group.

Tex-Tube, Inc. J. M. LeFan was named controller.

Universal Oil Products Company. Dr. L. G. Massey was named head of the computer department.

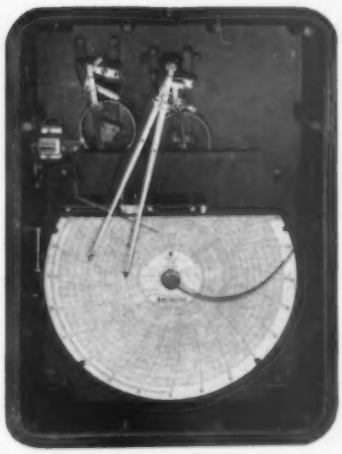
U. S. Industries, Inc. R. D. O'Brien was advanced to the post of group executive for the two petroleum equipment divisions. Until recently, O'Brien was secretary of USI.

Well Surveys Inc., one of the Dresser Industries. Dr. Howard Oshry was appointed technical director in charge of the company's extensive research, testing and prototype manufacturing facilities and personnel.

The Wheland Company. Rodney Freeman was appointed sales representative. He is currently being trained at the company's Chattanooga, Tennessee, plant, after this, he will work in the Louisiana, Mississippi, Arkansas, and upper Texas Gulf Coast area with headquarters in Lafayette, Louisiana.

Web Wilson Oil Tools, Inc. John W. Rife was appointed general manager, formerly serving as assistant to the president.

W-K-M division of ACF Industries, Inc. Robert O. Wynn was named vice president of engineering and research and Henry C. Tooley as vice president of manufacturing. Wynn has been vice president of manufacturing.



AMERICAN®
INTEGRATING
ORIFICE
METERS

American Integrating Orifice Meters provide more accurate measurement by the continuous multiplication of the square root of the measured differential by the square root of the absolute line pressure.

Single, double and duplex-integrating models available in a wide range of manometer types and working pressures. Dust-proof, die-cast aluminum cases... Gasclok and electric instrument chart drives. Also supplied with American Telecounter for remote readings.

Ask for Bulletin 401 for complete details.

AMERICAN® METER COMPANY

General Offices: Philadelphia 16, Pa.
Sales Offices in Principal Cities

Trade Parade

Koppers Company, Inc. John W. Pennington was named general manager of the piston ring and seal department of the Metal Products Division. Pennington was manager of engineering and development of the division.

William B. Sawers was appointed manager of the coupling department of the division. Sawers was assistant manager of the piston ring and seal department.

Polyken Sales Division. Alfred J. Spiry, previously the South Central sales representative, is now responsible for the Polyken sales department, international division, The Kendall Company. His activities will include all phases of overseas marketing of tapes and protective coatings products. Donald W. McCabe, previously responsible for the marketing of Polyken products by Kendall Company in Canada, has joined Polyken protective coatings at its Chicago headquarters as assistant merchandise manager. James C. O'Brien, until recently associated with Material Service Corporation, has become the Midwest representative for Polyken protective coatings, working out of Chicago. Robert L. Toney Jr., for the past ten years associated in sales and sales management with Baker Oil Tools, Inc., in Los Angeles, now represents Polyken protective coatings in the far Southwest.

William F. Lechler, most recently with Bechtel Corporation, will represent Polyken in a North Central territory with his home base at Kansas City, Mo. M. Lamar Bowden, previously the sales representative for industrial tapes on the West Coast, is now the Southeast representative. Joseph F. Batteer, John M. McGivern and James O. Kircher complete the territorial representation with more concentrated territorial assignments in the Northeast, South Central and Gulf South areas. W. J. Flaherty and Rex Shaw have moved into new functions as sales and service supervisors, Eastern and Western, respectively.

Kellogg Switchboard and Supply Company. Fred A. Rundle has been appointed Eastern region manager of Kellogg, communications division of International Telephone and Telegraph Corp. He was sales promotion manager.

Jones & Laughlin Supply Division. New salesmen are: R. H. Pollakowski appointed salesman at Borger, Texas; and R. A. Hammontree named salesman at Lake Charles, Louisiana.

New store managers are: Evan Smith, formerly salesman at Borger, to store manager at Borger; B. J. Ford promoted to store manager at Pampa, Texas; W. T. Fleming to store manager at Rangely, Colorado.

Houston Oilfield Materials Company. John N. Donhaiser has joined Homco as coordinator of research and development. He established practice as an independent consulting engineer and was retained by the Pan American International Oil Company. His work was completed for them in May.

New division managers are: Rocky Mountain division — Warren Hollier, headquarters in Casper, Wyoming; Eastern Louisiana and Mississippi division — Gene Webb, New Orleans, Louisiana; Western Louisiana division — E. C. Alford, Lafayette, Louisiana; South Texas division — R. M. (Wimpy) Freeman, Alice, Texas; West Texas and New Mexico division — C. J. Erwin, Odessa, Texas; and North Central division — Don Burton, Oklahoma City.

International Nickel Company, Inc. J. Stuart Anderson, resigned Deputy Provincial Treasurer of the Province of Manitoba has been elected assistant to the vice president and also assistant treasurer of The International Nickel Company of Canada, Ltd. Anderson has also been elected assistant vice president and assistant treasurer of The International Nickel Company, Inc., the company's U. S. subsidiary.

Jefferson Chemical Company. John M. Luger was appointed to the newly created position of assistant to the executive vice president. His major responsibility will be the preparation of studies on the various areas of management.

Houdry Process Corporation. Robert A. Blomquist, formerly of J. T. Baker Chemical Co., and Peter W. Hill, former Houdry development engineer, have joined the chemical sales department.

Albert & Harlow, Inc. Ray R. Sloan, was named manager of the newly-formed Engine Sales Division, Albert & Harlow, Inc., Caterpillar dealer in Tulsa serving eastern Oklahoma. He has been an engine field representative for Caterpillar Tractor Co. in the U. S., Canada, and Mexico.

Blaw-Knox Company. Granville M. Read, retired chief engineer of the Du Pont Company, has joined the company as consultant to the president in research, engineering, and development. V. A. Miller of Whittier, Calif., was named West Coast sales representative of the advanced projects department.

Kenneth W. Becker was appointed district manager, sales, for the Chicago district. Herbert A. Holman is new Chicago area district engineer, sales.

PIPELINES
are in the NEWS

Watch - WILLIAMS BROTHERS

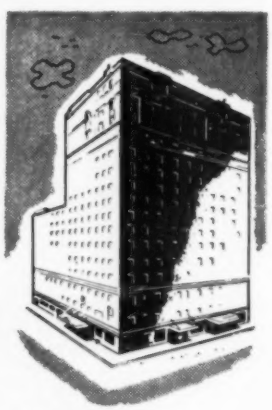
ENGINEERS-CONSTRUCTORS

Rockefeller Center — NEW YORK CITY
Washington — Pittsburgh — Louisville
Minneapolis — New Orleans — Caracas
Bogota — La Paz — Edmonton
Calgary — London — Ankara — Tehran

NBT BLDG.
TULSA
—
Cable
WILLBROS.

OIL • GAS • WATER • PRODUCTS
PUMPING STATIONS AND
PIPELINES

The Beautiful Lamar



Houston's Hotel of Distinction

You'll like the extra luxuries and comforts which distinguish The Lamar . . . It's completely air-conditioned of course, with TV and radio in guest rooms. And food to please the most discriminating. Rates begin at $4.50. Garage Service.

GEORGE B. ADAMS
General Manager

IN THE HEART OF THE THEATRE & SHOPPING DISTRICT

Trade Parade

ESTABLISHED WAREHOUSES. D&M Oil Field Specialty Company has located warehouses at Fort Morgan, Colorado, and Green River, Wyoming, for sales and service headquarters of B and W., Inc. — scratchers and centralizers — and Davis-Lynch, Inc. — float shoes and collars. Ralph Phillips is owner and manager.

SEATTLE OFFICE HAS NEW QUARTERS. The Dow Chemical Company announced its Northwest sales office has occupied new quarters on the second floor of the two-story Pacific Mutual Building, 307 Broad Street, Seattle.

The office layout features modern design, equipment and furnishings.

ENGINES ADDED TO LINE. A complete line of diesel engines will be added to the Chrysler marine and industrial engine sales line. An agreement has been signed with Klockner-Humboldt-Deutz of Germany, one of the largest diesel manufacturers in the world, and its subsidiary in the United States Diesel Energy Corporation in New York, to represent their high-speed engines in the U. S. Diesel Energy Corporation, who has already sold a considerable number of engines through their dealer and distributor organization, will cooperate with Chrysler in this merchandising program.

GRANT OIL ACQUIRES COSASCO. William B. Prosser, president of Perfect Circle Corporation, and Albert Salvatori, vice president of Grant Oil Tool Company, announced the acquisition of the assets and inventories of Perfect Circle's Cosasco Division to Grant Oil Tool Company.

HEADS CANADIAN FIRM. E. A. Johndrow, vice president of sales for the George E. Failing Company of Enid, Oklahoma, manufacturers of portable drilling rigs, has announced appointment of J. W. Cooper to be manager of Failing Canadian subsidiary, of Edmonton, Alberta. Cooper has been associated with the Canadian operations of the Failing company since 1945. Previously he was employed by Union Tractor Company of Canada.

Jimmy Helton, who managed the Failing Canadian subsidiary for the past four years, has been made West Coast District manager with headquarters in Oakland, California. Previous to going to Canada, Helton was manager of the Failing Branch Store at Midland, Texas.

OFFICER OF NEW FIRM. Appointment of Cooper F. Hawthorne as vice president and general manager of the newly-organized Metal Services, Inc., Box 1596 Port Neches, Texas, of the Beaumont-Port Arthur-Orange area, was announced by President J. H. Heslar of Beaumont. Hawthorne recently resigned the same offices, which he held for three and a half years with the Nowery J. Smith Co., of Houston.

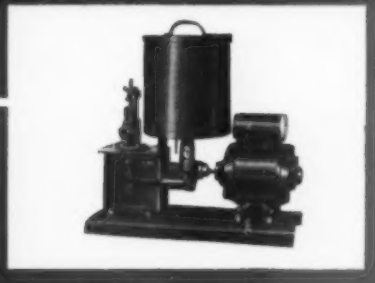
Metal Services, Inc., offers a complete range of corrosion prevention services to heavy industry and offshore operators throughout the middle Gulf Coast area. Hot-dip galvanizing in a 45-foot-long zinc kettle, largest in the South, will be offered, as well as metallizing, sandblasting, pickling, phosphatizing, oiling, painting, and chemical cleaning of carbon and stainless steel in the shop or in the field.

Baash-Ross Division of Joy Manufacturing Company. Fred Jackson has been transferred from Casper, Wyoming to Liberal, Kansas as salesman. Joe F. Bealer Jr. replaces Jackson in the Casper office and Leon McRae Gay joins Baash-Ross as salesman at Odessa.

assures precision metering !

CHEMICAL FEEDERS by Manzel give accurate, dependable metering of chemicals, acids, oils, and many other liquids. Rugged, trouble-free units are available in large or small capacities, with single or multi feeds, for any type of drive. Delivery from one cc/min/feed to one gal/min/feed, against pressures to 5000 psi. Consult your Manzel field engineer for full details and recommendations.

MANZEL



WRITE FOR FREE COPY of new Chemical Feeder Catalog. Detailed information permits you to select the right feeder for any job.

Manzel

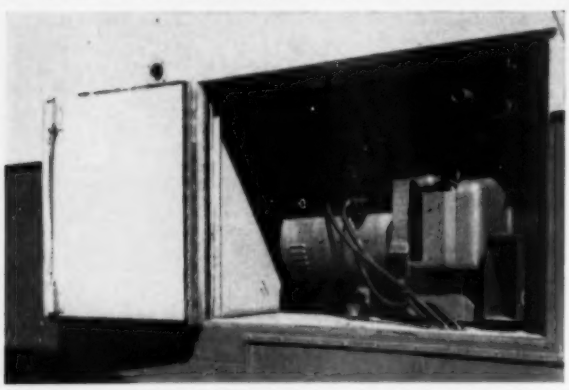
291 Babcock Street, Buffalo 10, New York

Specialists in metering pumps and lubricators since 1898

Onan NEWS REPORT

ELECTRIC WELL LOGGER operates on power from an Onan Electric Plant mounted within the truck. The 5,000-watt, two-cylinder, gasoline-powered Onan delivers uniform, dependable electric current . . . essential for precise measurements of well conditions.

PLENTY OF POWER for all surface and sub-surface needs of this versatile vehicle are supplied by the Onan unit. In addition to well logging, Onan electric power is used for casing perforation and other well servicing, lighting, and for operating an Ozalid printer.



COMPACT, QUIET-RUNNING Onan plant is easily accessible. Vacu-Flo air-cooling system allows installation in enclosed compartment. The Onan plant is generally in use for periods ranging from 2 to 6 hours but has been operated for 22 hours at a stretch. The plant will run continuously if required.

Models from 500 to 230,000 watts. Call the Onan distributor listed in your phone book or write for complete specifications.

D. W. ONAN & SONS INC.

ELECTRIC PLANTS GENERATORS ENGINES ENGINE-COMPRESSORS

3287 University Avenue S.E. • Minneapolis 14, Minnesota

Onan ELECTRIC PLANTS

Books to Read

The Earth Beneath The Sea, by *Francis P. Shepard. Published by The Johns Hopkins Press, Homewood, Baltimore 18, Maryland. Pages, 275. Price, $5.00*

With offshore drilling and production becoming more important in the oil industry, this new book will be interesting reading for all, and essential reading for those who have anything to do with the offshore work. "The Earth Beneath The Sea" is based largely on the work being conducted by Scripps Institution, with the aid of six ocean-going vessels. It is written by a professor of submarine geology at Scripps Institute, University of California.

Most of the geology we know is confined to land above sea level and yet about 72 percent of the earth's surface lies beneath the seas. This is an illuminating account of the latest discoveries in the geology of the sea along with interpretation of the origin of submarine topography and a discussion of the processes which are operating in the sea and along the coasts.

The Management of Scientific Manpower. *Published by American Management Association, Inc., 1515 Broadway, Times Square, New York 36, N. Y. Pages, 160. Price, $3.75 to nonmembers; $2.50 to AMA members.*

If you were to decide offhand the keystone of business organization today, wouldn't you say, "Research"? In the introduction to this volume, the statement is made that over 80 percent of the sales volume in a number of growing corporations results from products that were unknown 10 years ago. These figures reflect patterns characteristic of growth business. The introduction continues:

"To capitalize on technological advance as a basis for future growth and profits calls for dynamic and resourceful management thinking in applying scientific manpower in ways that will bring the greatest return to the company from the use of this scarce but strategic resource.

"Scientific manpower is assigned two major responsibilities in serving the corporation: research, on the one hand, and engineering on the other. Both are vitally important in the chain of events that leads to the profitable product innovation without which no company can survive over a span of years. An under-

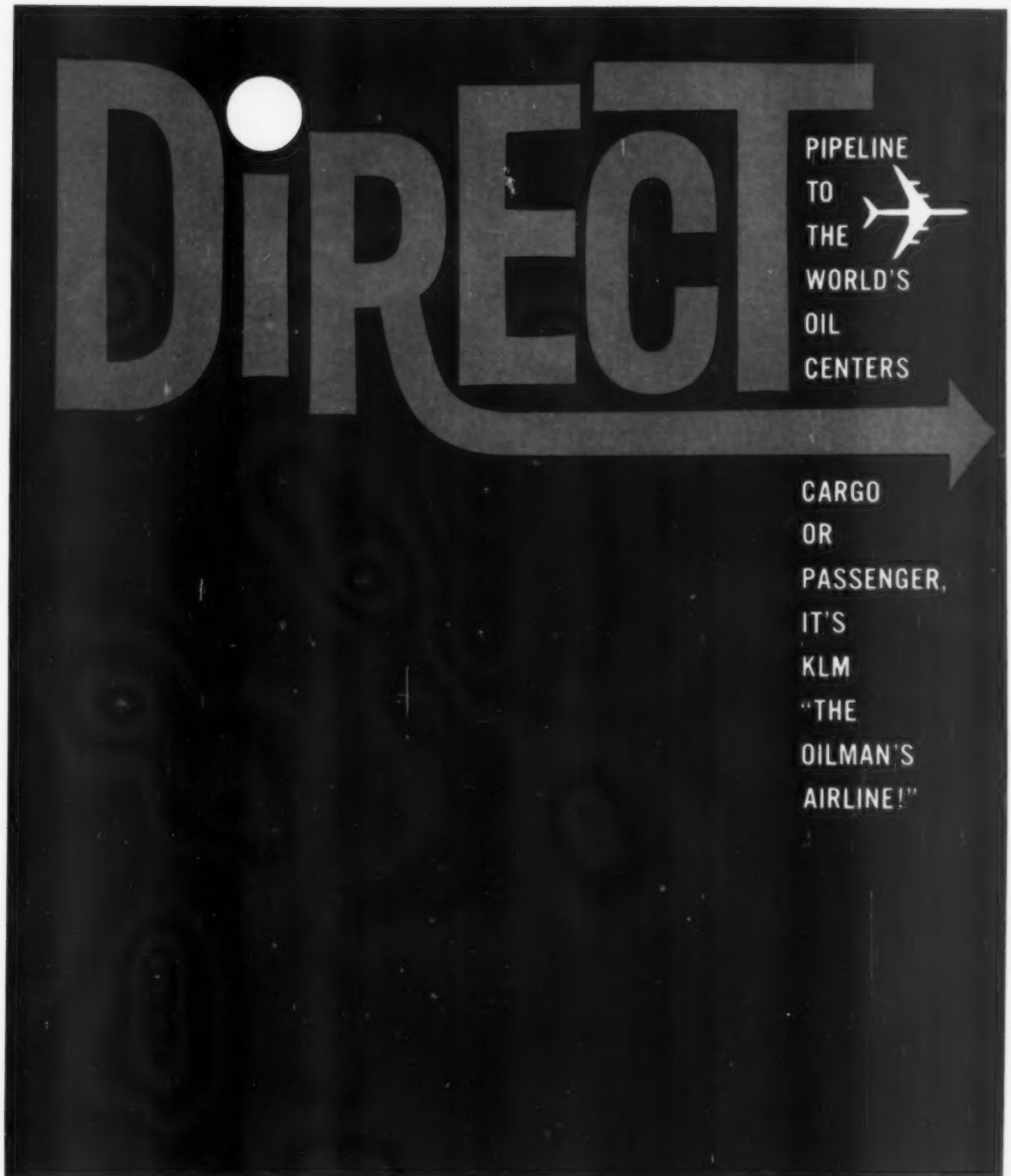
On all models of Kittell Silencers and Spark Arrestors!

Intake and exhaust models for every industrial, mobile and marine application. Shipped within 4 days after receipt of your order. Send for free, 24-page catalog. Tells how to select the proper silencer to solve your noise problem.

Kittell

Kittell Muffler and Engineering, Inc.
1977 Blake Avenue
Los Angeles, California

16 years experience in SILENCE!



FROM HOUSTON: direct to Europe, Africa, the Near, Middle and Far East. FROM MIAMI: direct to South America. Daily service. FROM MONTREAL: direct to Europe, Africa, the Near, Middle and Far East. FROM NEW YORK: direct to all Europe and beyond; also to Curacao, Aruba and South America. IMPORTANT: Your cargo receives rapid ground handling. Awkward shapes easily accommodated. FOR PASSENGER SERVICE: Call your Travel Agent or KLM office. For cargo service: Contact your Cargo Agent, Forwarder or KLM office.

KLM ROYAL DUTCH AIRLINES • 609 FIFTH AVENUE • NEW YORK 17, N. Y.

40 YEARS

THE WORLD OVER

KLM

ROYAL DUTCH AIRLINES

THE WORLD'S FIRST AIRLINE

Clean PIPELINES
Reclaim TANK BOTTOMS

with

BrakeSol®

an exclusive

PARAFFIN TREATING CHEMICAL

BRAKESOL holds paraffin in suspension! Inject it into gathering lines and BRAKESOL keeps them free of paraffin.

BRAKESOL reclaims tank bottoms without taking tanks out of service! BRAKESOL chemically dissolves paraffin and puts it back in solution into the oil. Cost is nominal compared to savings.

BRAKESOL is safe to handle and will not harm your equipment. Let BRAKESOL eliminate your paraffin problems NOW!

FOR SERVICE . . . Contact your Supply Store or nearby BrakeSol Treating Engineer.

BrakeSol INC.

P. O. BOX 9506 • OKLAHOMA CITY, OKLA.
EXPORT DISTRIBUTOR: THE NATIONAL SUPPLY CO., EXPORT DIVISION

standing of the roles and responsibilities of both research and engineering is essential to the effective administration of these programs."

As in other AMA reports each of 15 chapters is written by authorities in various companies. The petroleum industry is represented by a chapter on "Developing Research Objectives," by C. A. Day, Manager of Research and Development, Richfield Oil Corporation.

▸ **Atomic Power and Energy Resource Planning,** *by Richard A. Tybout. Published by Bureau of Business Research, College of Commerce and Administration, The Ohio State University, Columbus Ohio. Pages 98. Price, $2.00.*

This monograph brings together the latest information on world energy resources and needs. It compares estimates of several authorities of energy resources and predicted consumption.

The author found a roughly equivalent percentage improvement in per capita real national income with greater per capita consumption of fuels, indicating the close alliance between energy use and economic growth.

This volume will have considerable appeal to economists in the energy industries, but some of the author's statements will be regarded right now with considerable argument in the petroleum industry. He states, for instance, that "World reserves (of fluid fuel) are unlikely to meet projected needs for the remainder of the 20th Century." With steadily increasing reserves despite the increase in consumption, it is difficult to see the peak of production and of reserves in the next 25 to 50 years. Dr. Tybout concludes that atomic power offers a valuable, long-run supplement to the world's energy resources. He feels, however, that it will have very little to do with economic development of under-developed countries. He points out that atomic power will cost more than conventional power in the United States for many years to come.

▸ **Oil Well Cementing Practices in the United States,** *published by the American Petroleum Institute, Division of Production, 300 Corrigan Tower Building, Dallas 1, Texas. Pages, 297. Price, $5 ($5.75 foreign).*

This newly-published story of oil well cementing techniques, equipment and applications represents the collective effort of more than 100 individuals, representing oil producing, service and supply companies everywhere. While some background into the history of cementing—some dating the practice applied to oil wells to 1883—most of the volume is devoted to chemistry of cements, planning cementing programs, cementing practices and tools and equipment, regulations and unique applications.

A complete bibliography, including over 2300 references to articles and patents (dating from 1824 through 1958) relevant to oil well cementing, is listed chronologically and cross referenced.

▸ **Rinehart's 1959 Yearbook,** *published by Rinehart Oil News Company, 2300 Reagan, Dallas, Texas. Pages, 392 in two volumes. Price, $25 to Rinehart News subscribers; $35 to non-subscribers.*

The new double-volume publication contains thumbnail completion histories of 2652 discoveries, major extensions, and important wildcat failures drilled during 1958 in 29 active areas. Each individual section is illustrated with state, regional, and field maps, supplemented with highlights of significant development trends.

▸ **Technical Societies Guide,** *published by the Industrial Publicity Association, Technical Societies Committee, Room 1616, 41 East Forty-Second Street, New York 17, New York. Pages.*

A new reference manual of procedures required by technical societies and trade associations for presentation and preparation of papers has been prepared to serve as a reference for both the industrial publicist and engineer by giving specific procedures for formal presentations of technical papers and the preparation of asscoiated publicity.

Prepared in cooperation with 36 leading technical societies, the guide contains data on: Membership structure, number of members, principal meeting dates, subjects of interest, paper requirements, mechanics of contribution, policies on reprints and reprints, restrictions and rights to papers and data on each society's publication and publicity policy.

▸ **Business Investment Policy,** *by George Terborgh. Published by Machinery and Allied Products Institute and Council for Technological Advancement, 1200 18th St., N. W., Washington 6, D. C. Pages, 260. Price $8 to MAPI member copanies; $10 to non-members.*

Machinery and Allied Products Institute (MAPI) has gained a reputation for exhaustive research in certain economics areas. Business Investment Policy is a good example. Introduced by an extensive discussion of the problem and formulas that have been used, a new theory is developed and analyzed. Then the author, MAPI's research director, shows how the formula can be applied in specific instances. The book is concluded with management's part in investment policy.

Grove 36" Seal-O-Ring—World's Largest Thru Conduit High Pressure Pipeline Valve...Shown at the 1959 IPE

We're being imitated!

The Tulsa Show proved it. And we're glad because imitation, it's said, is the sincerest form of flattery. We enjoyed the talk about NEW Floating Seats; REVOLUTIONARY "O" Rings; AMAZING Pressure Seals and HIGHLY ADVANCED Non-Wedging Action . . . since we've had all of these things (and more) since 1953.

These "brand new" engineering-design features have been the reasons why today, Grove sells the major share of all large pipe line valves in the world. More and more valve users have recognized the operating advantages of Grove's Seal-O-Ring design. And judging from all of the "news" in Tulsa, our competition has, too.

But, imitating a design is one thing; duplicating Grove's experience or patented construction is quite another.

Grove valves—with full thru conduit; an effective metal to metal primary seal plus "O" ring cleaning and sealing action—have been proven in over 6 years' use. The "O" rings, manufactured in Grove's own rubber plant, from Grove's own formula, are completely protected in an over-sized groove. No danger of cutting or abrasion resulting from gate action. Heavy mechanical springs keep the seats in line all the time. And you never lubricate . . . See your Grove man soon. Get all the facts.

GROVE VALVE and REGULATOR COMPANY

A Subsidiary of Walworth

65th & Hollis Street, OAKLAND 8, California

HOUSTON 27—3203 Mercer St. • LOS ANGELES 6—2559 W. Olympic Blvd.

ODESSA • TULSA • DENVER • CHICAGO • NEW YORK • DALLAS • PITTSBURGH

FARMINGTON, N. M. • LAFAYETTE, LA. • HARVEY, LA. • LONGVIEW, TEXAS

In Western Canada: GROVE VALVE LTD., EDMONTON

anti-stalling
anti-rust

GULF agent

Your customers have sure protection against carburetor icing when you stall-proof your gasoline with Gulf Agent 178. For more than four years, this additive has proved itself in millions of cars and billions of miles of service. Gulf Agent 178 is easy to use, because it is readily soluble in all petroleum products and blends easily at temperatures from minus 30° to plus 140° F. It is insoluble in water and can be used in conventional gasoline transfer systems with no danger of loss from water leaching. Gulf Agent 178 is inexpensive, too. Only 10 to 15 pounds are required per thousand barrels of gasoline. No expensive storage space is required, since quantities are so small. Lastly, Gulf Agent 178 gives you an extra benefit by providing corrosion protection at no extra cost. Rust prevention lengthens the life of distribution and storage facilities all the way from refinery to customer. Gulf Agent 178 can make your gasoline a better, more saleable product. Let us show you how. Write or phone Petrochemicals Department Sales Office, Gulf Oil Corp 360 Lexington Ave. New York 17, N.Y.

GULF

Quality Chemicals from Petroleum

Laugh with Barney

An executive has a worried look on his assistant's face.

Two kittens were watching a tennis match. One turned proudly to the other and said: "My pop's in that racket."

The young colored girl was in the hospital for a check-up.

"Have you ever been X-rayed?" asked the doctor.

"Nope," she replied, "but ah've been ultra-violated."

A sign for Smith Brothers cough drops on a billboard read "'Take one to bed with you."

A woman driving by remarked to her companion, "They'd have to shave first."

A recent survey shows that while old folks prefer mild winters, young married couples like nice springs.

We heard the other day that the cannibal best-seller is: How To Better Serve Your Fellow Man.

There's a little line on the ocean where by crossing you can lose a day. There's one on the highway where you can do even better.

There's a new gadget that keeps the inside of your car quiet. It fits tightly over her mouth.

A Sultan at odds with his harem
Thought of a way he could scare 'em;
He caught him a mouse
Set it loose in the house
Thus starting the first harem-scarem.

Vacations are easy for the average man — the boss tells him when he can go, his wife where, and finance company how much he can spend.

Elderly Lady: My, my! You are an apt young boy. Is your sister apt, too?

Little Boy: Yes'm. She apt to if she gets a chance.

One vacationer reports seeing this sign in a restaurant on his travels: "Pies like mother used to make before she took up bridge and cigarettes."

Although all women are alike in many respects, there are certain sectional differences. For example, a northern girl will say, "You may." But a southern girl will say, "You-all may."

Did you hear about the absent-minded sculptor who put his model to bed and started chiseling on his wife?

Henry, when you was in the big city did you go into any of them places that had a sign up over the door that said "GIRLS, GIRLS, GIRLS?"

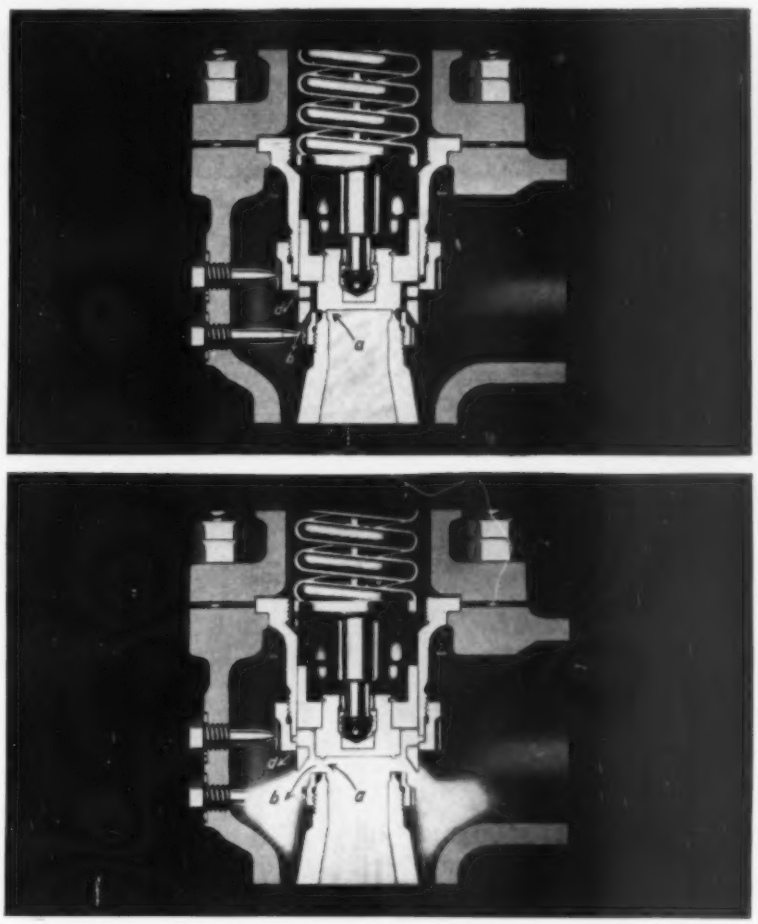
No, but I got throwed out of a place that had a sign over the door saying "WOMEN."

What is an abortion called in Czechoslovakia?

I give up. What?

A cancelled check.

Look into Lonergan Valves



Top: Valve closed, ready to pop. Pressure confined within throat chamber. Bottom: Open. Full (D/4) lift obtained at standard over-pressure. Orifices (a) and (b) full open, port (d) sealed off. Full pressure on baffle area.

Here's the valve that sets the industry standard for reliability, safety and economy.

Lonergan V and W series valves are designed to provide full power at the *end of lift* when opening. This means full lift, thus maximum capacity flow at a low accumulation.

Through the control principle shown here, Lonergan valves close cleanly, without shock and can be adjusted to the application requirements for either vessel or line, on blowdown.

The opening point of Lonergan valves is consistent. Capacity is assured. In addition, the non-shock closing eliminates damage to the seats, thus reducing maintenance and product loss due to seat leakage.

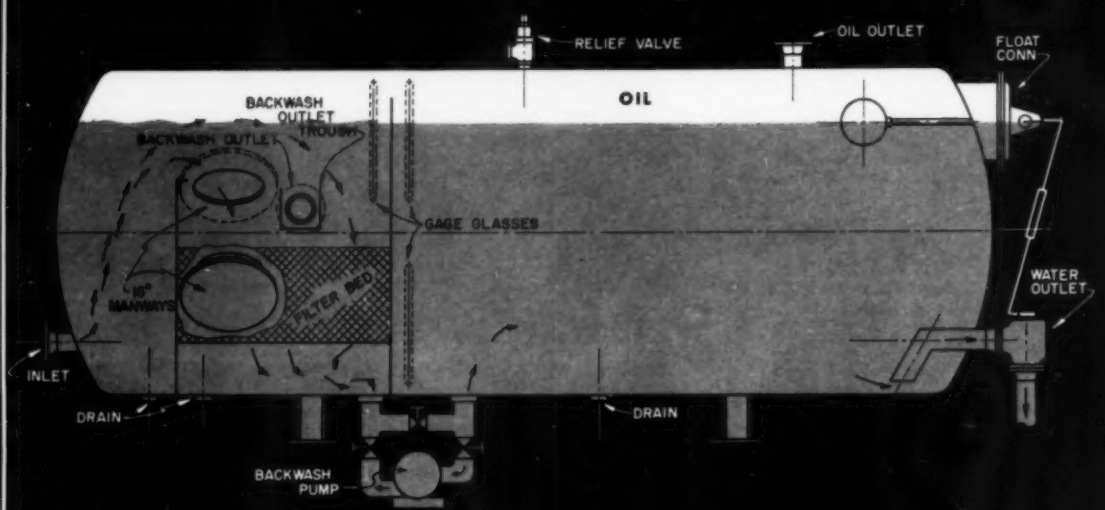
Full details on the Lonergan V and W series of valves for process industries are given in catalogs 900-V and 1000-V. Write for your copies today.

Lonergan

J. E. LONERGAN CO., 205 RACE STREET
PHILADELPHIA 6, PA. SINCE 1872

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

ON WATER FLOODS OR WATER DISPOSAL PROJECTS, PROTECT YOUR INJECTION WELLS WITH A . . .



NATIONAL®

OIL WETTED PARTICLE REMOVER & COALESCER

This vessel is especially designed for water having entrained "oil wetted particles" such as iron sulphide. Normal excelsior sections will become rapidly plugged handling this type of water. With the National Oil Wetted Particle Remover and Coalescer, oil wetted particles are filtered out and finely dispersed oil particles are coalesced to particle size sufficient to rise out of the water to be skimmed.

SKIMMING WITHOUT COALESCING WILL NOT GET THE JOB DONE.

This vessel is used in place of the National Precipitator and Oil Remover where the water contains large quantities of solids. It has the feature of being able to backwash the filter and coalescing compartment with water from the conditioned water compartment.

Contact the National Representative nearest you

It's a National®

NATIONAL TANK COMPANY

DRAWER 1710

TULSA, OKLAHOMA

USE THIS ENVELOPE

to begin your subscription

to the Edition of THE PETROLEUM Engineer

edited expressly for you!

TEAR OUT AND MAIL. NO POSTAGE NEEDED IN UNITED STATES.

THE PETROLEUM ENGINEER
DRILLING & PRODUCING
SPECIALIZED EDITION

- ☐ $6.00 for 3 years
- ☐ $5.00 for 2 years
- ☐ $3.00 for 1 year

THE PETROLEUM ENGINEER
FOR MANAGEMENT
INTEGRATED (ALL INDUSTRY) EDITION

- ☐ $18.00 for 3 years
- ☐ $14.00 for 2 years
- ☐ $ 8.00 for 1 year

REFINING ENGINEER
SPECIALIZED EDITION

- ☐ $6.00 for 3 years
- ☐ $5.00 for 2 years
- ☐ $3.00 for 1 year

PIPELINE ENGINEER
SPECIALIZED EDITION

- ☐ $6.00 for 3 years
- ☐ $5.00 for 2 years
- ☐ $3.00 for 1 year

FOLD INTO ENVELOPE AND SEAL

☐ **Payment Enclosed** ☐ **Invoice Me** ☐ **Invoice Company**

Check, Money Order or Draft may be safely enclosed in this envelope

THIS IS NOT AN EXPIRATION NOTICE

NAME_____

COMPANY_____

POSITION_____

ADDRESS_____ ☐ HOME ☐ COMPANY

CITY_____ ZONE____ STATE_____

DO NOT WRITE BELOW
NUMBER
DATE
AMOUNT
FOLIO

Please check division of industry engaged in:

- ☐ Drilling
- ☐ Drilling Contractor
- ☐ Producing
- ☐ Ind. Producer
- ☐ Gas Pipe Line
- ☐ Crude Oil Pipe Line
- ☐ Products Pipe Line
- ☐ Pipe Line Contractor
- ☐ Refining Contractor
- ☐ Natural Gasoline
- ☐ Refining
- ☐ Petrochemical

FOLD ON THIS LINE

FROM

FIRST CLASS
Permit No. 1091
DALLAS, TEXAS

BUSINESS REPLY MAIL
NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY

THE PETROLEUM Engineer
PUBLISHING COMPANY
P. O. BOX 1589
DALLAS 21, TEXAS

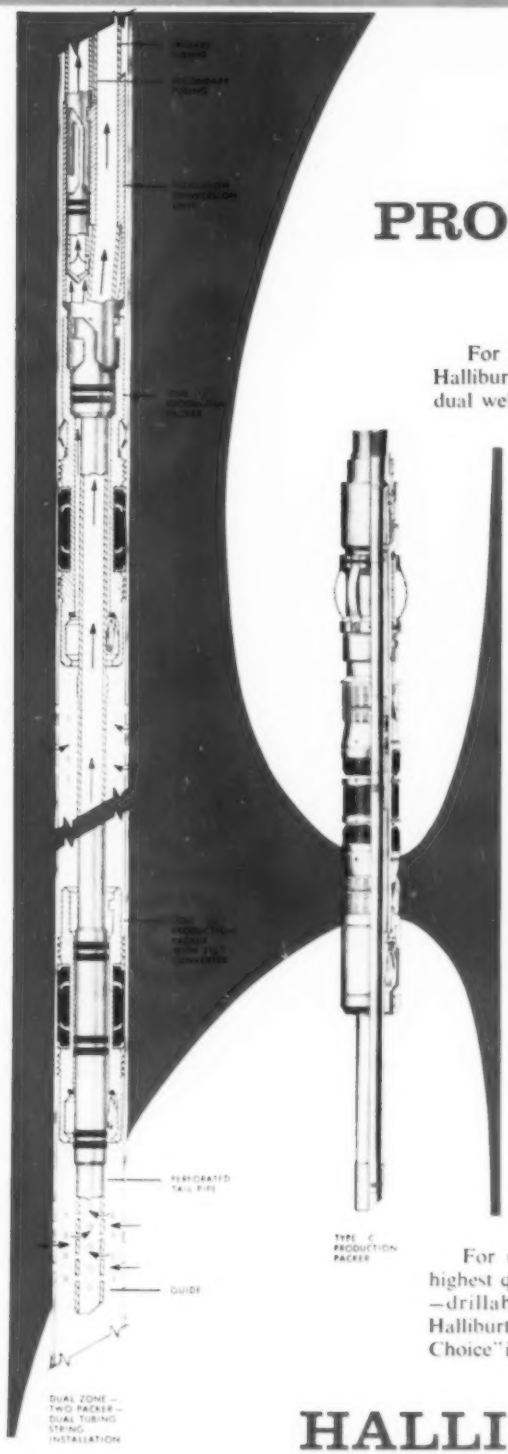
FOLD ON THIS LINE

Use this envelope to begin your subscription to the Edition of

THE PETROLEUM Engineer

edited expressly for you!

FOLD ON THIS LINE



Where production performance counts...

Get the HALLIBURTON PRODUCTION PACKER best suited for the job!

For ease of operation and dependable drillability you can select Halliburton Type "C" and "CL" Production Packers for single and dual well completion.

***Match the advantages** of Type "C" and "CL" Production Packers to the individual requirements of your well:*

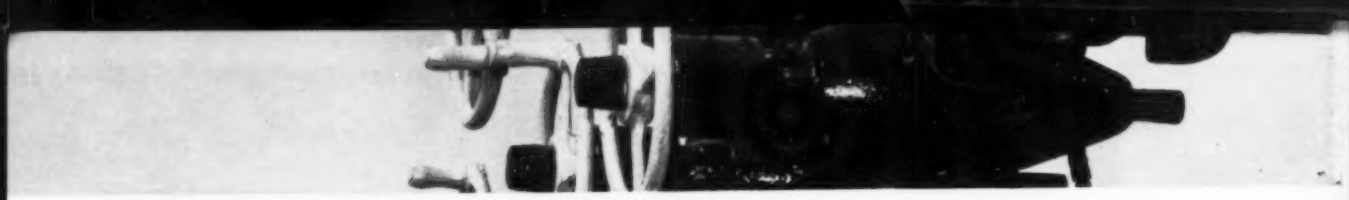
- Drillable material withstands up to 10,000 psi differential pressure—highly resistant to corrosion and harmful fluids.
- The sealing unit and tubing are loose from packer before well treatment begins or well is placed on production.
- Packers permit use of standard tubing as tail pipe.
- Full opening—packer also adaptable for fracturing work.
- Back pressure valve helps to eliminate loading producing formation with mud or water when removing tubing from well or out of packer.
- Packer is suitable for gas or water injection wells—readily adaptable to permanent type completions.
- Retrievable sealing plug dropped on top of packer permits testing—treating and squeezing upper zone... easily retrieved with tubing.
- Expendable sealing plug run on the packer protects lower zone from pressure and fluid when treating above—can be expended by small amount of tubing weight as sealing mandrel enters packer.
- Sealing unit and extra seal elements help provide a tight fluid or gas seal in packer.
- J-Latch Sealing Unit may be used to anchor tubing to packer and place tubing in tension.
- Type "C" Production Packer is run on tubing or drill pipe.
- Type "CL" Production Packer is designed for electrical wire line setting on Halliburton Powder Type Setting Tool.

For unequalled field performance in production packers—only the highest quality can give dependable service. For economy—dependability—drillability—easier operation... plus savings in time and money—Halliburton Type "C" and "CL" Production Packers are still "First Choice" in the field. Write for a copy of the new brochure number S-8027.

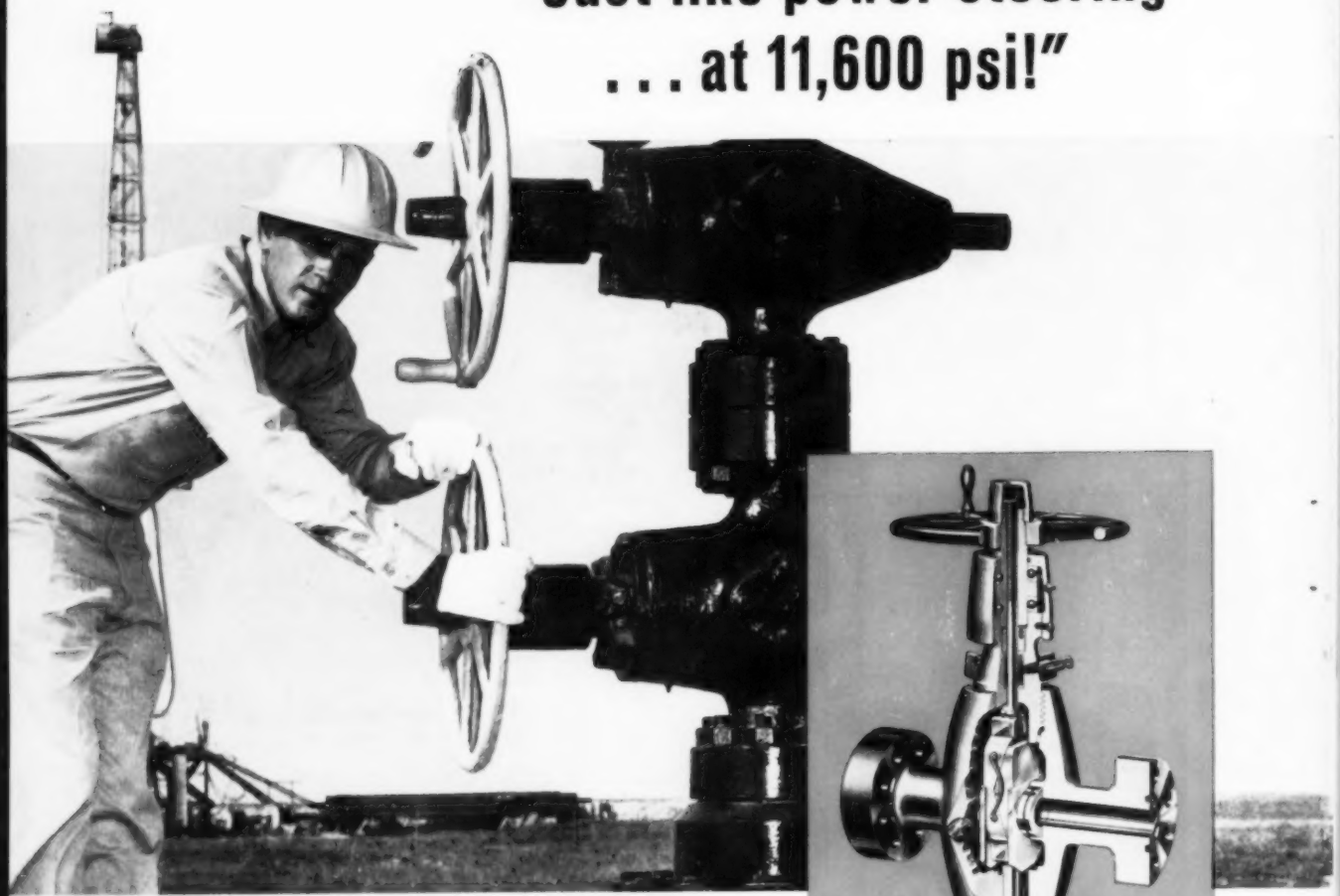
HALLIBURTON Cementing Services

284 Service Centers—Just Minutes Away From Your Well

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA



"Just like power steering . . . at 11,600 psi!"



W-K-M® Balanced Stem Valves

These valves are the easiest operating high pressure valves ever made.

Only W-K-M Balanced Stem Valves are designed to overcome the heavy thrust loads carried by bearings and threads in single stem valves. A second stem is attached to the bottom of the gate to balance out body pressure that acts against the operating stem. The only loads to be overcome in opening or closing this valve are packing friction and normal operating loads.

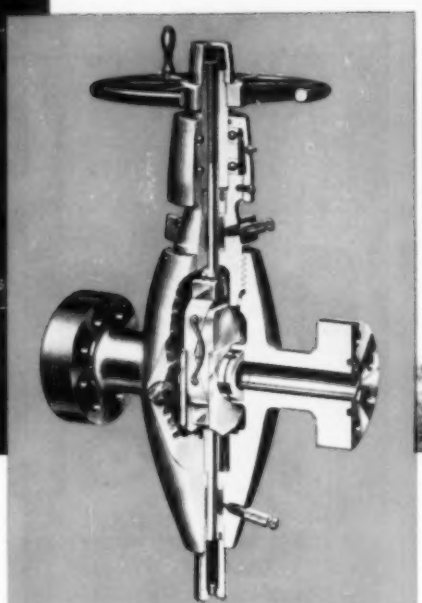
Next time — and every time — specify W-K-M! *Available at leading supply stores everywhere.*

PRODUCT OF W-K-M's *Creative Engineering*

WRITE FOR CATALOG 200

W-K-M Division of
ACF Industries, Incorporated
P. O. Box 2117, Houston, Texas

W-K-M
SERVING INDUSTRY 40 YEARS



W-K-M Balanced Stem Valves feature through-conduit gate construction, parallel expanding gates, controlled force seating, pressure seal bonnets, super-finished stems supported on roller bearings, seating surfaces sealed away from the lading flow.

Sizes: 1-11/16" through 2-9/16".

Working Pressures: 10,000 and 15,000 pounds.

Write for Test Bulletin WP-1058. It describes how this superlative valve successfully passed the oil industry's most punishing tests.

5912

Of Things To Come . . . In Oil

OIL AND GAS FUTURE FOR KANSAS is brighter than ever before, as result of major exploration developments resulting last year in increasing proved natural gas reserves 4.9 percent, and a total liquid hydrocarbon crude reserve of 1.12 billion bbl. A report just released by Kansas State Geological Survey points out slightly decreased oil and gas production and less drilling activity, but notes 136 new oil fields, 16 gas fields, and five oil-and-gas fields opened last year. Drilling for oil in the Sunflower state began in 1860.

NO FURTHER MAJOR CRUDE PRICE DROPS are expected to result from Atlantic Refining's reduced posting in East Texas, and from Great Northern Oil Purchasing Company's decreased rate for Weyburn type Canadian crude. Domestic producers, who fear similar slashes in price in East Texas and in the U.S.-Canadian border area, have appealed both cuts. It is generally felt that since the East Texas price also determines certain Venezuelan crude postings, thus affecting the world market, major companies will be slow to follow Atlantic's price adjustment. Some Canadian and U. S. border producers are refusing to ship to companies offering lower prices; also, certain groups felt that if Canadian prices fall too low, thus flooding this market, import restriction gates might swing shut.

HELIUM PRICES ARE EXPECTED TO RISE, both for raw helium-bearing natural gas and for processed gas. Raw gas is now being sold to government for 19 cents per Mcf, and processed gas, stored by government, is valued at $19 per Mcf. Reason for price rise: (1) Respected voice of Navajo Tribal Council, Paul Jones, denouncing Bureau of Mines for its "ridiculous price fixing" of helium prices, and "dictatorial policies," will be heard in Washington; and (2) concern on part of officials that present prices will not sufficiently encourage private industry to construct 12 new helium processing plants it considers necessary. Gas industry officials place worth of purified helium near $44 per Mcf.

OIL IN MISSOURI has been discovered at a shallow depth in McDonald County, in the southwestern part of the state, but no "boom" is immediately foreseen — as may be the case in non-productive Iowa, where oil is being smelled — since most leases are taken. Oil from the Missouri discovery well is being trucked to an Oklahoma refinery and oilmen are watching production developments of the well before further exploiting the find. A few gas wells are in the area, though no oil has heretofore been found — although oil search first began in 1890.

A New Name . . .
For An Old Hand In
OIL FIELD SERVICES

PGAC

Pan Geo Atlas Corp.

FORMERLY:

Perforating Guns Atlas Corporation

PAN . . . . denotes PGAC's world-wide operations
GEO . . . . denotes PGAC's geological applications
ATLAS . . denotes PGAC's original name (1946)

598

7730 SCOTT STREET HOUSTON 21, TEXAS
Phone: RE public 4-1651 P. O. Box 14524

PGAC is a Subsidiary of
CHEMETRON
CORPORATION

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

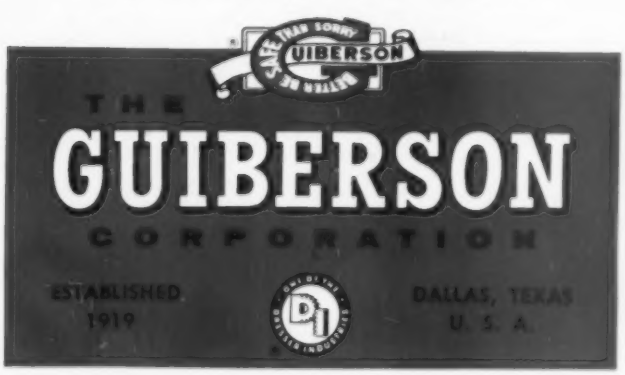
SHORT COMPACT RUGGED

GUIBERSON'S SHORTY TENSION PACKER *for* WATER FLOODING

Here is a rugged, low-cost retrievable tension packer that's short and easy to handle. Uncomplicated and functional in design, it's easy to set, space out and spot . . tension set by pulling on tubing string. And Guiberson's shorty tension packer is priced to cut your costs . . designed especially for water flood injection wells.

SAFETY JOINT COUPLING: right hand release 8 round thread for added safety.
ANCHOR CAGE: one piece malleable iron.
MANDREL: full opening heavy one piece seamless steel tubing.
LATCH: dependable J-slot mechanism, shock-absorber equipped, independent of safety joint operation.
FRICTION PADS: heat-treated pearlitic malleable iron.
SLIPS: heat-treated alloy steel.
HEADS: drillable cast iron.
RUBBER: specially compounded to withstand the most rugged oilfield use at high pressures and temperatures—built-in ability to return to original shape.
THIMBLE: drillable cast iron.
SAFETY RELEASE NUT: predetermined tension load at packer strips out, leaving safety nut, thimble, rubber and head—all drillable.

Sold by Oil Field Supply Stores Everywhere



FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

BROWN OIL TOOLS

Continually launching new developments for tomorrow's production

Brown CAM-LOK Packer. New Development — most economical and versatile packer available. Use as a tension or weight-set packer, tubing anchor or tubing catcher.

Brown HS-8-5 Hydraulic-Set Retrievable Packer. New Development — to be used as uppermost packer when producing five zones through independent tubing strings.

Brown HS-16-1 Hydraulic-Set Retrievable Packer. New Development—latest hydraulic-set packer for use in single zone completions or as bottom packer in multiple completions. Handles extremely high differential pressures.

Complete information on these new developments, the CAM-LOK HS-8-5 and HS-16-1 packers, is available at all Brown Oil Tool locations. Day in and day out, Brown packers operate safely, efficiently to provide maximum economy for the operator.

BROWN
OIL TOOLS, INC.

8490 Katy Road, P. O. Box 19236, Houston, Texas

Ask your Brown representative about the full line of production equipment, liner equipment, specialty and fishing tools.

ENLARGING TOOLS?

GRANT Makes Them All!

Any hole enlarging problem can be met economically with tools made by Grant. You may be opening a rat-hole off a whipstock... enlarging hole for the casing or production string... or underreaming for a thicker cement sheath. From a single source – Grant – you can get the right tool for the job at hand.

Grant is the world's largest manufacturer of hole enlarging tools, developed during more than 30 years of experience providing oil men with the finest tools of the oil trade.

When hole enlarging is your problem – in any well, anywhere – it pays to know that, in enlarging tools, *Grant makes them all!*

This is just one of the three *families* of Grant Tools made for reaming, hole enlarging and stabilizing. For full information on these, and a wide range of other down-hole and surface tools made by Grant, send for your copy of the complete Grant Catalog *today!*

GRANT OIL TOOL COMPANY

Main Office and Plant:
2042 EAST VERNON AVENUE, LOS ANGELES 58, CALIFORNIA
Cable Address: GRANTOOL

AVENAL, BAKERSFIELD, COMPTON, VENTURA, WILLOWS, CALIFORNIA • LIBERAL, KANSAS • HARVEY, HOUMA, LAFAYETTE, LOUISIANA • LAUREL, MISSISSIPPI • FARMINGTON, HOBBS, NEW MEXICO • NEW YORK, NEW YORK • OKLAHOMA CITY, OKLAHOMA • CORPUS CHRISTI, HOUSTON, ODESSA, TEXAS • CASPER, WYOMING • EDMONTON, CANADA

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

THE OLD "WORK HORSES" OF PRIMARY CEMENTING

The preponderant use of Larkin Floating and Guiding Equipment is a natural result of its years of dependable performance.

Experience brings confidence — and that's why thousands upon thousands of wells each year are cemented through Larkin Equipment.

FIG. 302

FIG. 322

FIG. 401 M&F

FIG. 202

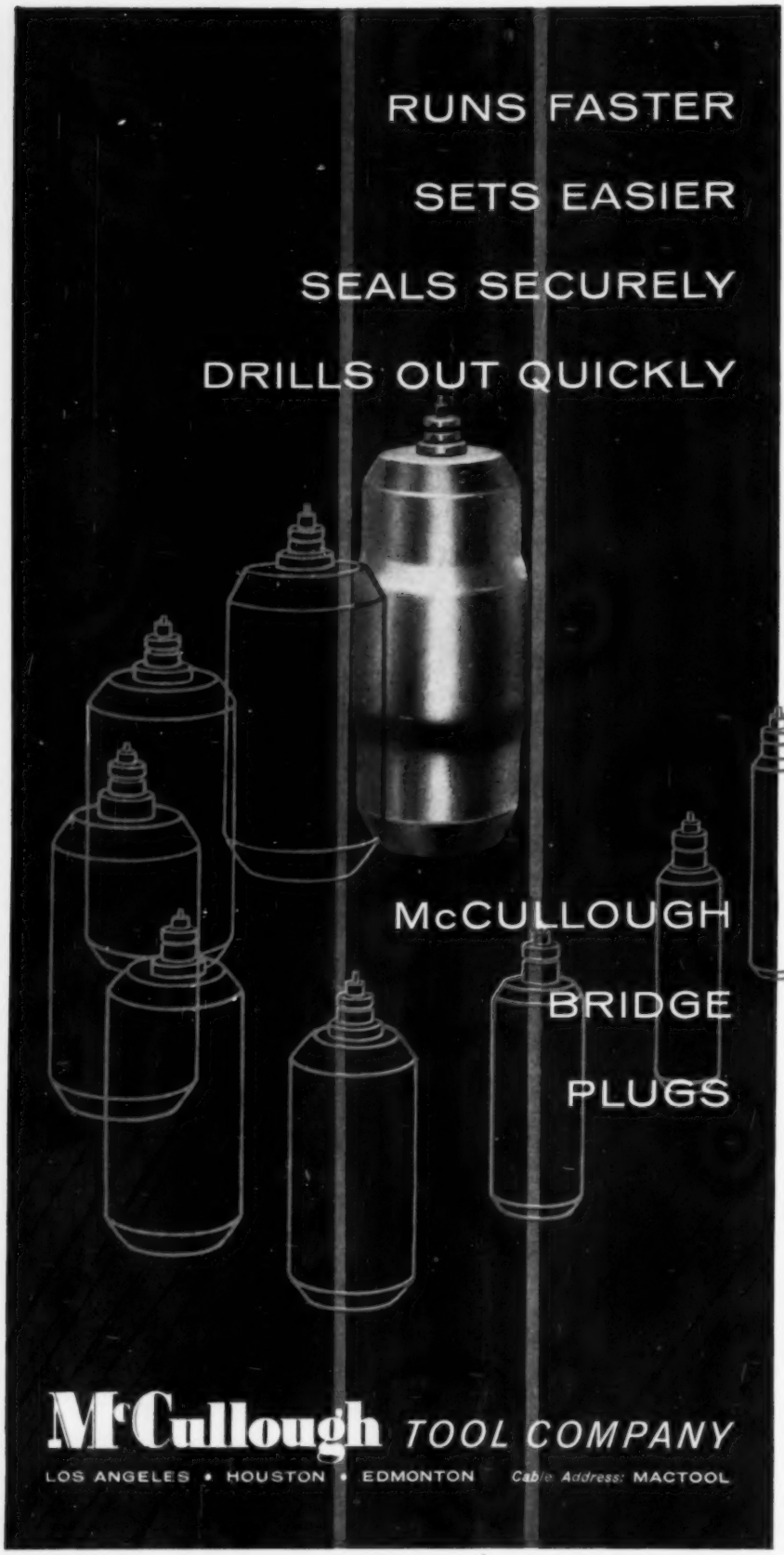
LARKIN

...Through Your Supply Store

LARKIN PACKER COMPANY, INC.

WAXAHACHIE, TEXAS

LARKIN LEADERSHIP HAS BEEN EARNED BY YEARS OF DEPENDABLE PERFORMANCE



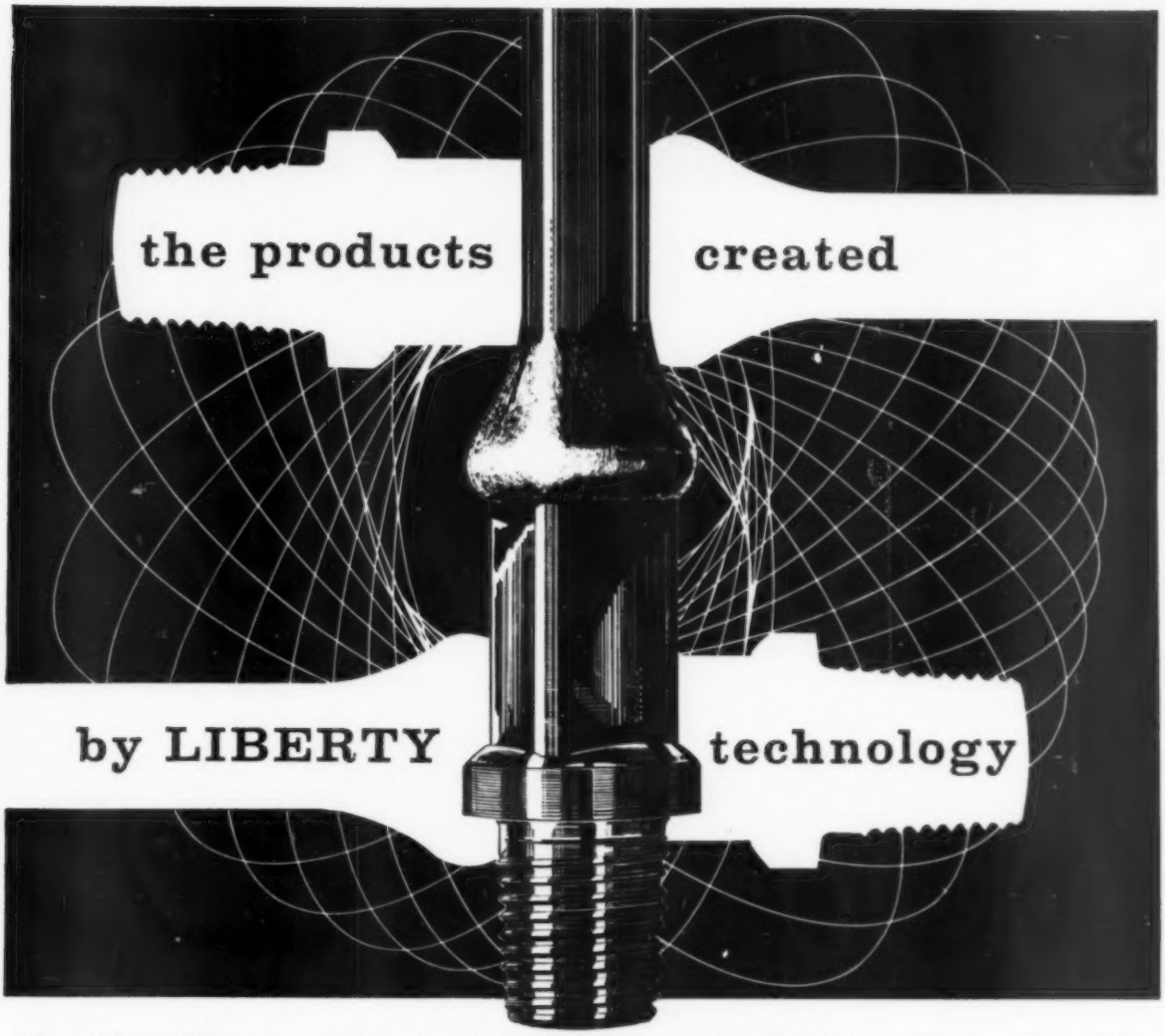
Here's the answer for a truly efficient, all-purpose bridge plug – one so simply constructed, with no moving parts, that it will not fail mechanically – so positive in sealing action that you get a leak-proof seal under hydrostatic pressures as high as 13,000 psi – yet so versatile it will successfully accomplish the most difficult plugging operations as well as the easiest.

The McCullough Bridge Plug is an explosive-expansion plug made of drillable aluminum. It is set at the desired location by the power of expanding gases from within the plug. On permanent installations it will last as long as the pipe in which it is set. It is ideal for temporary plugging operations as it drills out quickly and easily with a rotary bit.

TAKE A LOOK AT THESE FEATURES

- Simple, one-piece, all-aluminum construction. Slips, reins, rubber packers and all hardened or moving parts that might impede drilling out have been eliminated.
- No slips to hang up or accidentally trip and set the plug while going in the hole.
- Makes a positive leak-proof seal under the heaviest hydrostatic or mechanical loads.
- Easier on the pipe than a slip-type plug.
- Because it's shorter and smaller in diameter it easily passes through tight spots, dog legs, etc., and saves rig time in running, locating and setting.
- Drills out easier and faster.
- Resists corrosion and electrolysis.
- Available in 37 sizes from 1¾" OD to 10½" OD for tubing, drill pipe, casing and in open hole in hard formations.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Daily Show Their EXCELLENCE in the Field

Save 10% to 33⅓% on pumping from low fluid-volume wells to 5,000 feet, with the LIBERTY ½-INCH SUCKER ROD–the newest product of LIBERTY technology.

To get complete information on the LIBERTY ½-INCH SUCKER ROD, send today for technical information.

All LIBERTY products are sold only in Supply Stores, through the LIBERTY SERVICE NETWORK.

There are many reasons for the excellence of LIBERTY SUCKER RODS and PUMPING UNITS but there is only one final proof: the performance which LIBERTY products give in day after day of hard field use.

In this way, LIBERTY SUCKER RODS and PUMPING UNITS have been serving the oil production industry for over 40 years, in every kind of pumping condition.

LIBERTY Field Representatives bring the same quality of excellence, in their training and experience, to assist you in designing installations for maximum efficiency in your pumping operations.

To learn more about LIBERTY products and services, write or call–

LIBERTY

MANUFACTURING COMPANY OF TEXAS

4025 HEMPHILL STREET • FORT WORTH, TEXAS

LM-9

GARDNER-DENVER uses WAUKESHA

for reliable and profitable

COMPRESSOR POWER

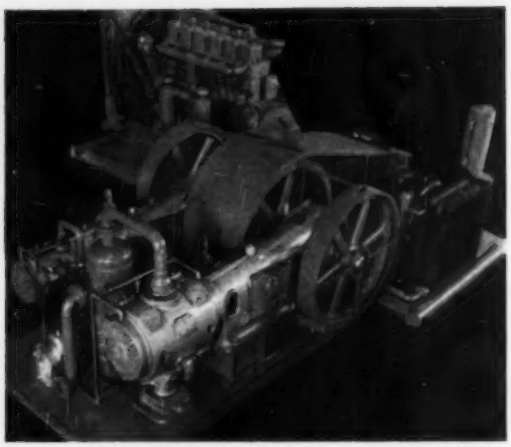
All the proven features that insure long engine life and the ability to withstand overloads, and that result in low maintenance costs and economical operation, are built into these Waukesha engines . . . from precision-counterbalanced rugged crankshafts; pistons, rings, and rod and pin assemblies in matched sets, to built-in automatically lubricated governors and big capacity cooling and oiling systems. The line is complete; you can get exactly the right power for your needs. You cannot buy better engines for continuous heavy duty compressor operation.

Send for engine bulletin 1699.

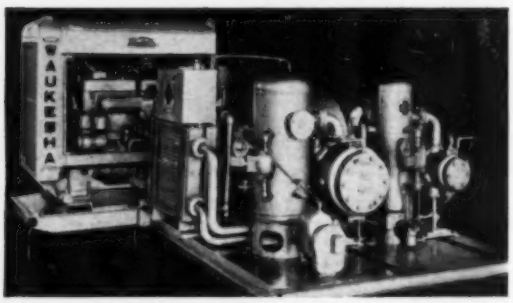
WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.

NEW YORK TULSA LOS ANGELES

Factories—Waukesha, Wisconsin, and Clinton, Iowa



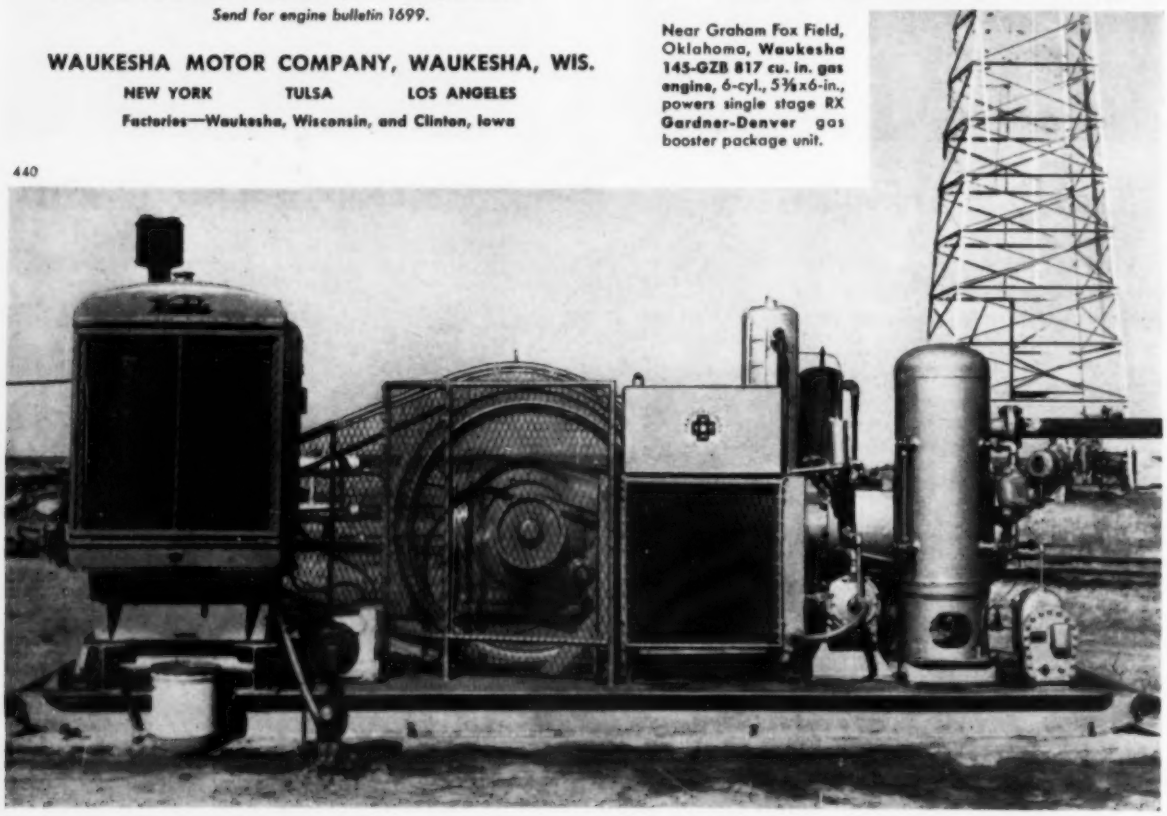
Waukesha LRORB 2894 cu. in. gas engine, 6-cyl., 8½ x 8½-in., powers 2-stage RX **Gardner-Denver** gas booster package unit.



Waukesha WAKB 1197 cu. in. gas engine, 6-cyl., 6¼ x 6½-in., powers 2-stage RX **Gardner-Denver** gas booster package unit.

Near Graham Fox Field, Oklahoma, **Waukesha 145-GZB 817 cu. in. gas engine,** 6-cyl., 5⅜x6-in., powers single stage RX **Gardner-Denver** gas booster package unit.

440



To Open-Hole Straddle Test
Eliminate Tail Pipe
Insure a Good Packer Seat

specify the new Johnston Open-Hole Anchor

Many advantages are offered with this New Johnston Open-Hole Anchor. This is a slip-type device which has wide application because of its flexibility.

The slips are designed and built to give an extra large expansion diameter. This insures seating in wells where the hole may be slightly over drilled diameter.

The Open-Hole Anchor is easy to operate — has simple, positive-action "J" setting. A spring locking nut, incorporating buttress threads, allows easy re-setting of the anchor. When testing is completed, 6 turns to the right allows you to rotate out of the hole.

THE PROOF---

Hansford County, Texas
Conventional test at 8800′ in 7⅞″ hole. Used Anchor and single Bob Tail Packer only. No tail pipe. Mud weight 9.8 lbs., estimated 120,000 lbs. on packer and setting tool. No slipping of tool, no problems. Test successful.

Hansford County, Texas
Straddle test in 7⅞″ hole between 3,000′ and 4,000′. Anchor set on first attempt. No wash pipe used. Test successful.

Hansford County, Texas
Straddle test in 7⅞″ hole between 6,000′ and 7,000′. Tool set on first attempt. No wash pipe used. Test successful. Second test run between 5,000′ and 6,000′. Packer failed to seat in washed out hole. Moved up hole, tool and packer set on first attempt.

Hansford County, Texas
Straddle test in 7⅞″ hole between 5,000′ and 6,000′. Tool set on first attempt. No wash pipe used. Test successful.

Liberal, Kansas
Straddle test between 5,006′ and 5,016′. Tools worked well. No trouble. No wash pipe used. Test successful.

Liberal, Kansas
Selective zone tests between 3,907′ and 3,915′ and 4,672′ and 4,680′. No problems encountered. Tools worked perfectly. No wash pipe. Test successful.

Liberal, Kansas
Two straddle tests run between 4,662′ and 4,678′ and 4,577′ and 4,614′. Both tests O.K. No trouble whatsoever. Tools worked as expected. Test successful.

You can profit from the savings in dollars and time when you specify the Johnston Open-Hole Anchor. Ask your Johnston representative for full information. You'll be glad you did.

JOHNSTON DRILL STEM TESTING TESTERS

Eliminates the need for tail pipe on conventional tests and straddle tests.

Offers flexibility in finding packer seat. If seat is not obtained on initial attempt just pick up and re-set the tool.

P.O. Box 98, Houston 1, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

The Image of CF&I *assures top quality in*

SEAMLESS
CASING AND TUBING

The CF&I giant stands for skill and long years of experience in producing quality steel products. And in the petroleum industry, users have learned to rely on CF&I's craftsmanship for straight, strong and "true" seamless casing and tubing.

CF&I's advanced production equipment and techniques—from special heat treatment to precision threading, plus a system of meticulous inspections—is your guarantee of quality casing and tubing. Made from top quality steel, CF&I Seamless Casing and Tubing are subjected to rigid manufacturing standards and meet API STD 5A specifications. They are available in sizes 2⅜" through 9⅝" O.D.

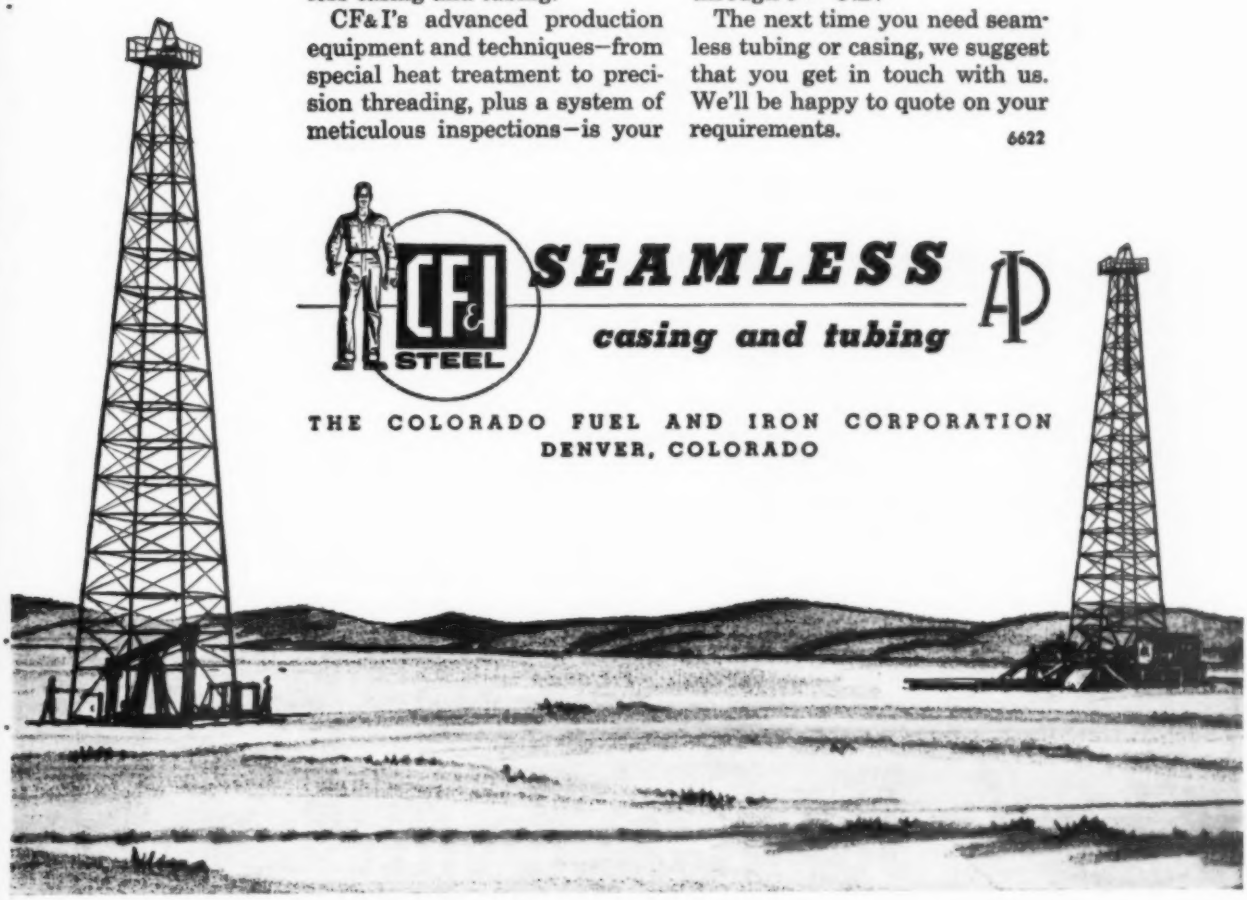
The next time you need seamless tubing or casing, we suggest that you get in touch with us. We'll be happy to quote on your requirements.

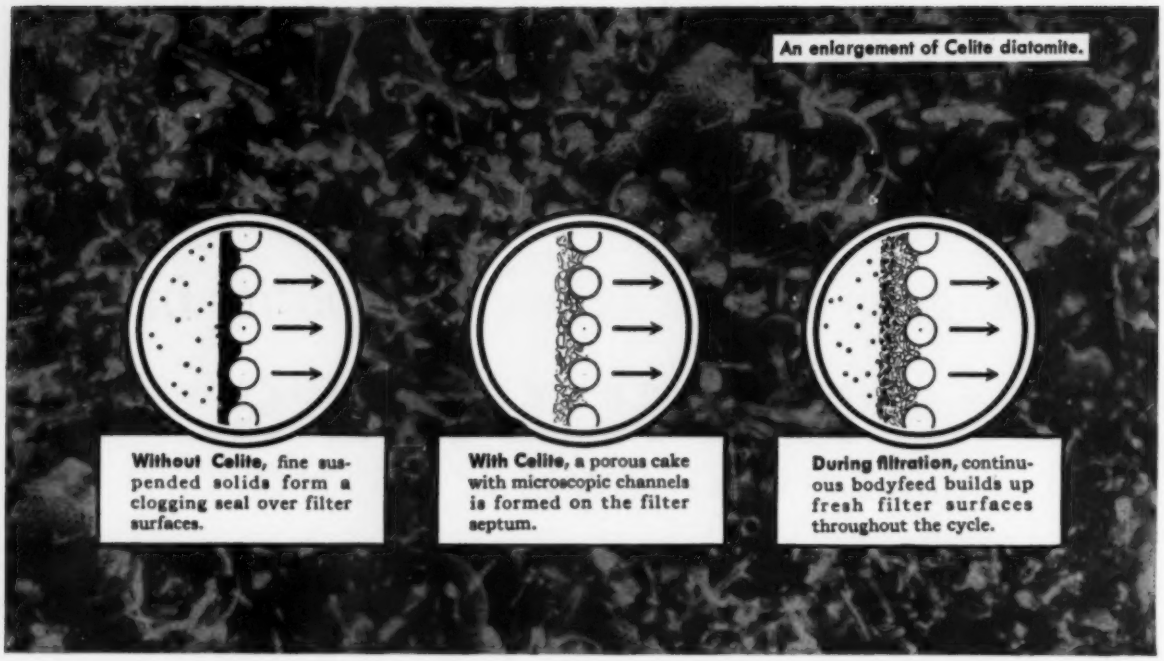
6622

CF&I STEEL

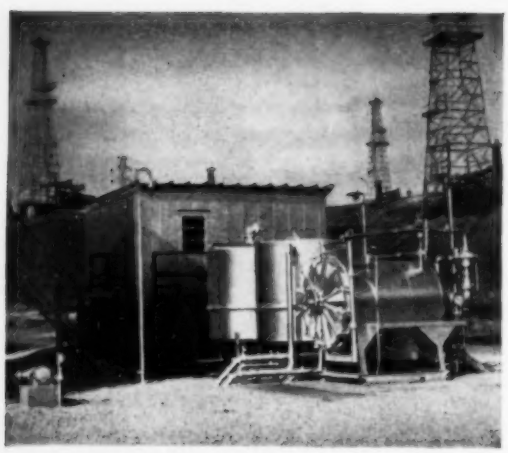
SEAMLESS API
casing and tubing

THE COLORADO FUEL AND IRON CORPORATION
DENVER, COLORADO




An enlargement of Celite diatomite.
Without Celite, fine suspended solids form a clogging seal over filter surfaces.
With Celite, a porous cake with microscopic channels is formed on the filter septum.
During filtration, continuous bodyfeed builds up fresh filter surfaces throughout the cycle.

How Celite's 2,000,000 tiny channels per cu. in. remove all suspended solids from injection water!



These small, movable, skid-mounted filters can only be used with diatomite filtration.

Celite is Johns-Manville's registered trademark for its diatomaceous silica products.

THESE CHANNELS—so small the unaided eye can't see them—take all the pore-clogging, suspended solids out of repressurizing water in injection systems. They are so tiny they even remove algae and amoebae, yet they provide the fastest flow rates.

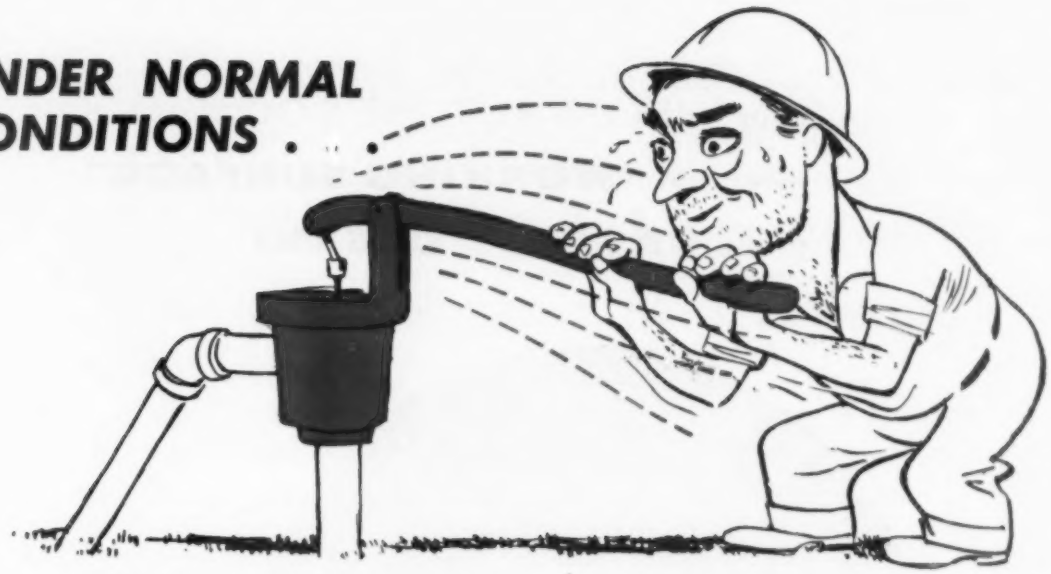
To you, this means maximum clarity of injection water. It also means fast, economical operation from a plant that uses ten times *less space* than other systems. When cleaning is needed, minimum backwashing removes the cake, quickly and cleanly.

Because of the wide variations in filtration problems, Celite is processed into 9 standard grades to meet every requirement. And Celite gives you consistently better results because it is more uniform from bag to bag than any other diatomite.

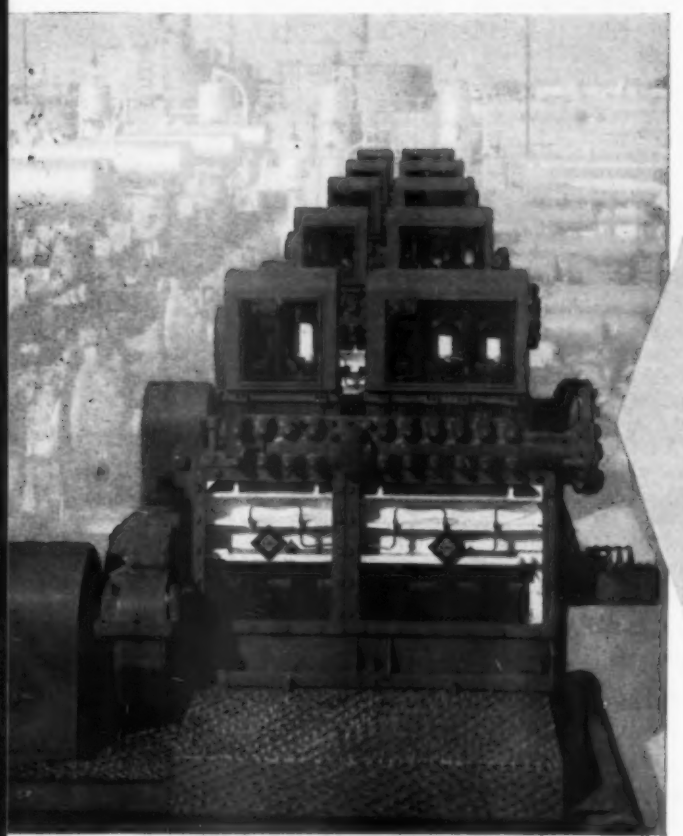
A Celite filtration engineer is available to assist you on your injection water problems. Call your local J-M office or write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE

UNDER NORMAL CONDITIONS . . .



Any Good Pump will do the Waterflood Job



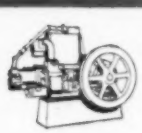
"Five Ajax Quintuplex pumps on Long Beach project."

. . . but Ajax builds in anticipation of troublesome suction conditions—water hammer—excessive loads—high stress, fatigue causing conditions . . .

Thus an Ajax pump reduces down time and increases "ON THE LINE" pumping time.

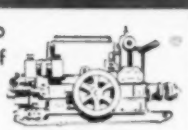
- Streamlined discharge manifold — reduces turbulence
- Double row tapered permanently factory adjusted roller main bearings result in lowered maintenance cost.
- "Safety Link" Tie Rods — protect vital components during highly abnormal conditions

AJAX OIL FIELD PUMPS



ENGINES

AJAX also builders of

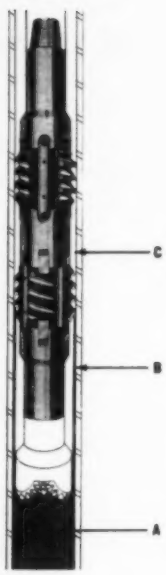


COMPRESSORS

AJAX IRON WORKS CORRY, PENNSYLVANIA

OIL FIELD DISTRIBUTORS: The National Supply Co., Pittsburgh, Pa.
• Bethlehem Steel Company, Supply Division, Tulsa, Oklahoma

your WELL'S FUTURE LOOKS GOOD when the **"WORKING SURFACE"** of the **CASING** is **CLEAN!**



A – Cement to be drilled out.
B – This thin cement sheath, which remains after the bit has passed, often interferes with future operations.
C – Cement sheath and ALL other obstructions removed by the Baker ROTO-Vert Casing Scraper. The vital I.D. of the casing is left clean and smooth, safe for all future down-hole operations.

It's simple and inexpensive to run a Baker Casing Scraper just above the bit when drilling out cement, or following perforating operations, to provide a bright future for your well.

No obstructions will remain to cause premature setting of close-tolerance tools. Rust, mill scale and paraffin will be scraped away, and there will not be any sharp burrs to slash and ruin swab rubbers or affect the performance of packing elements on testers, packers and cement retainers. Even the thin, brittle cement sheath which prevents the slips of pack-off tools from gripping the casing, are scraped away.

Thousands of runs have proved the Baker ROTO-VERT Casing Scraper to be both positive and safe in cleaning up casing I. D. easily and at low cost.

Available from the Baker Servicepoint in your area, on a rental basis.

BAKER OIL TOOLS, INC. HOUSTON LOS ANGELES NEW YORK

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

THE ATLANTIC LECTURES OF THE UNIVERSITY OF TEXAS

A Frontier in Reservoir Technology:

Reservoir Inhomogeneity Assessment and Control

PART 11

Reservoir inhomogeneities — what are they and what effect will they exert on recovery? A better knowledge in this area will lead to methods to mitigate some adverse effects of inhomogeneities

C. A. Hutchinson, Jr., *Supervising Research Chemist, Atlantic Refining Company, Dallas, Texas*

ALTHOUGH WE HAVE BEEN producing oil from reservoirs for almost 100 years and have been trying to engineer reservoir injection recovery processes for 40 years, we still are inadequately informed about one of the main components of the system. This is the reservoir rock itself. A tremendous number of reservoir rock samples, the oil field cores, have been examined and analyzed. For a few locations in a reservoir we know the mineral composition of the rock, the porosity, and the permeability. Beyond this point our real knowledge becomes sparse.

It is appropriate to ask whether we really need to know much more about the rock. Briefly — yes! Rock variation from point to point significantly affects our reservoir injection operations. To know the effect, and to engineer a field operation properly accounting for the effect, we must first recognize and understand the problems. Proper consideration of reservoir inhomogeneities in the engineering of a given reservoir injection operation may well spell the difference between profit and loss, or at least in degree of profit. Fortunately, in most cases reservoir engineers can estimate the range of likely effect of inhomogeneities in a way to permit management to take acceptable calculated risks on reservoir projects.

We are not able to change these inhomogeneities — at least not in the foreseeable future. Similarly, we cannot now control the weather. But we are supposed to know enough to "come in out of the rain." Our desire is to know enough to "come in out of the rain" as far as reservoir inhomogeneities are concerned.

Reservoir Rock

Reservoir rock must contain pores, or voids, to permit storage of oil and gas in pools. These pores must have some type of interconnection so that the rock is permeable to oil and gas. The problem of nonuniformity of the reservoir rock has its start at the size level of the pore space. There is a wide variation among reservoir rocks in size of individual pores and arrangement of pores with respect to one another. Levorsen[1] classifies the variations as primary if they are controlled by (1) depositional environment of the rock, (2) degree of uniformity of particle size, and (3) nature of the materials that make up the rock. Variations fall into a second class if they depend upon events that have happened to the rock since deposition. Such events include (1) fracturing and shattering, (2) solution, (3) redeposition and cementation, and (4) compaction because of increased load. From these categories and classes we see many possibilities for occurrence of reservoir nonuniformity. The product of sedimentation and subsequent events listed we have all seen in oil field cores. There has been a number of color pictures of cores in recent advertising.[2] These are excellent and show inhomogeneities clearly.

Pore-by-Pore Nonuniformities

All academic and industrial petroleum production research laboratories have at some time made a porous system of unconsolidated sand to simulate the reservoir rock. This has involved the use of a clean quartz sand with only a moderate range of particle size (i.e., 150-175 mesh) packed carefully in a pipe or tube. At first we all thought this would be a uniform porous system. For some purposes it can well be so considered. For others we find that it is not homogeneous on a pore-by-pore basis and that this nonuniformity has an effect upon some of the reservoir processes. For example, there is every reason to believe that if an absolutely uniform sand pack of constant wettability were water flooded we would sweep all the oil from the pack — no residual to water flood. We do not find this to be so in our sand packs. The residual oil to waterflooding is fairly low, in the order of 5 to 10 percent of the pore space. We thus conclude that this is a fairly uniform system compared to natural consolidated systems which show higher residuals, but is still not uniform.

Laboratory observations. Before we go into a discussion of the effect of pore size variations, let us be sure we recognize they exist even in what should be our best controlled, most uniform laboratory system. Since we cannot see into a sand pack, we will look instead into a glass pack. This is the glass observation flow cell which we[3] and others[4] have used in microscopic studies of flow behavior in porous media. It consists of two essentially parallel glass plates separated by 0.01 in. Space between these plates is packed with glass frit (crushed pyrex) that is

graded to an approximate diameter of 0.003 in. The system is strongly water wet, but in this particular instance wettability is not important. Porosity of this system is about 40 percent and permeability is very high.

In Fig. 1 we see the front when a wetting phase (oil) is displacing a nonwetting phase (air). Here we see a front that appears to move uniformly through the cell. Residual air is left behind just as residual oil (nonwetting) would be left behind if water (wetting) were pushed into an oil reservoir.

Next we will push the oil from this flow cell with the same oil, but colored. This is a miscible displacement with a mobility ratio of one. The flood front is shown in Fig. 2. Note that the front has advanced somewhat nonuniformly into the glass cell. There is no residual initial oil because this is a miscible displacement and capillary forces are not present. Viscous forces are the flow-controlling factor. The nonuniform advance of the flood front gives us some indication of cell nonuniformity.

Next we miscibly displace the heavy oil with a light oil. Here we have an unfavorable mobility ratio, i.e., less viscous fluid pushing the more viscous fluid. Flood front for this situation is shown in Fig. 3. Mobility ratio is about 10 (unfavorable). Here we see an extremely nonuniform flood front advance. We feel that in general the nonuniformities of a reservoir have magnified effects when unfavorable mobility ratios are used.

These three illustrations show us several facts. First, a system may be uniform as far as one operation is concerned and not for another. (Compare Fig. 1 and Fig. 3.) Second, even a carefully packed laboratory system is not truly uniform.

Capillary forces. Let us look briefly at the waterflooding process with particular concern about effects of pore-by-pore differences in the rock. The paths that water takes through the pore spaces are not random, unreproducible paths. Water is forced into (or perhaps it is better to say "sucked" into) these pores by capillary forces. Pores that will be flooded are "selected" because of the capillary pressure variations which in turn are established by wettability and pore geometry of a particular rock. Since there are flow paths down which water will imbibe more rapidly than others, the water will encircle and cut off some oil into discontinuous globules. This holds for the normal water-wet system. The discontinuous oil globules are residual oil and the amount of residual oil so trapped is a function of the pore geometry of the rock.

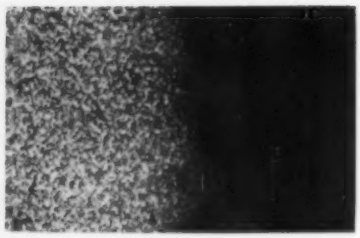


FIG. 1. Flood front through a glass frit observation flow cell illustrates imbibition type displacement of a nonwetting phase (air) by a wetting phase (oil). Flow is from left to right.

FIG. 2. Flood front through same cell shown in Fig. 1 illustrates miscible displacement of oil with the same oil, colored. Mobility ratio is unity, since the two fluids are identical.

FIG. 3. Flood front through cell illustrates miscible displacement of the relatively heavy oil with a light oil. Unfavorable mobility ratio (here around 10) magnifies the effect of flow cell nonuniformities.

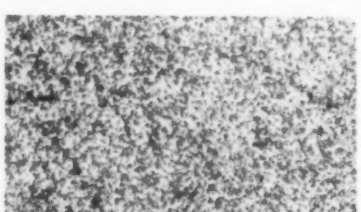


FIG. 4. Residual oil configuration in a waterflooded bead cell resulting from tests made to determine effects of pore-to-pore inhomogeneity.

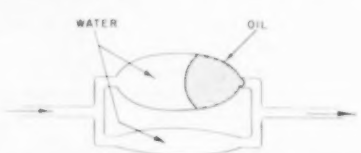


FIG. 5. Pore doublet model, representing reservoir flow channels, illustrates effects of capillary forces on the flow of oil and water through reservoir pores.

In a given system, such as the glass frit observation flow cell, we may repeat waterfloods many times. Residual oil configuration in a bead cell is shown in Fig. 4.

It is interesting to note that in these tests we found that amount and, more significantly, location of the residual oil is not a chance event. In each test the size, shape, and location of the residual oil globules are the same as in previous tests if we operate under the same starting conditions.[3,4,5] This indicates that there is some constant factor controlling the by-passing and cutting-off of residual oil. This factor is the pore-by-pore inhomogeneity and is the basic precept of the "Viscap" concept of Moore and Slobod.[6] This concept has its shortcomings, but it is useful in visualizing formation of residual oil.

Pore doublet. The reservoir is a jungle of multisize, intertwined capillaries. Let us examine a pore doublet, shown in Fig. 5.

In the pore doublet a single capillary divides into two flow channels of different sizes which then join to a single capillary again. The reservoir may be considered as containing a vast number of these basic units, all connected. This is, of course, an overly simplified model. Imagine further that the system is preferentially water-wet but is initially filled with oil. When water enters the single capillary on the left it will imbibe to the junction point where two paths become available. There are two forces controlling the water-oil movement. First are the viscous forces tending to retard flow. By Poiseuille's equation we know the smaller the capillary, the greater the viscous forces. Thus, if only viscous forces were significant, water would move more rapidly down the large capillary and bypass some of the oil in the smaller capillary. However, we must also consider capillary forces tending to imbibe or "suck" water into the capillaries. This force is greater in the smaller capillary and water under capillary force alone would go down the smaller flow channel more rapidly and would bypass oil in the larger flow channel. Effects of the viscous and capillary forces are actually combined in the reservoir, but capillary forces are in general so much more significant under reservoir conditions that the water rapidly displaces the small capillary and leaves oil in the larger. If the capillaries were exactly the same size (both in length and diameter) no by-passing would occur. This points out again that at least from this standpoint our most carefully prepared laboratory sand packs are not uniform,

for no one has made such a system that has zero residual oil to waterflooding!

Sandstone reservoirs are much more uniform on a pore-by-pore basis than are nonintergranular, nonintercrystalline limestone reservoirs. Vugs and solution channels of the limestone reservoir result in nonuniformity of a much greater degree. This is readily apparent from simple visual observation of cores.[2]

There have been numerous attempts to measure pore-size distribution of reservoir rock. Various methods tried have included analysis of grain sizes,[7] relative permeability characteristics,[8] porosity and permeability relations,[9,10] mercury injection into the pores,[11] pore space castings in plastic,[12] and capillary pressure curves.[13,14] None of these is ideal. Probably the most widely discussed and used is the analysis of capillary pressure curves. The capillary pressure curve, however, does not measure pore sizes but does reflect in part the pore entry sizes.

We have discussed the effect of pore-by-pore inhomogeneities on residual oil to waterflooding. There are other places in which the effect of nonuniformity is evident. One is in relative permeability curves. In an oil-gas system with both phases present, the sum of the relative permeabilities to each phase is not equal to one. It is generally significantly less. This is a direct result of nonuniformity on a pore-by-pore basis. We do not now, however, have a sound theoretical basis for converting from pore size distribution to relative permeability curves or vice versa. The capillary pressure curve is affected by pore entry size distribution. This, in turn, may reflect pore size distribution. The initial saturation conditions in a reservoir are primarily set as an equilibrium between gravity and capillary forces. Thus, pore-by-pore uniformity or nonuniformity plays a role in setting reservoir conditions at the time of discovery.

Miscible displacement. With the advent of the relatively new miscible displacement processes we find another area affected by pore-by-pore nonuniformity. This is in the mixing of the miscible slug or solvent bank with the displaced oil and with the gas displacing the slug. Were the pores uniform, there would be no convection or "mechanical" type mixing, and molecular diffusion alone would control slug dissipation. However, at flow rates of about one foot per day and greater, the convectional mixing due to pore-by-pore nonuniformity is apparently the controlling mixing mechanism. There is some question as to whether or not diffusion controls at lower rates.[15,16] At the higher rates we find a significant effect on amount of mixing caused by differences in uniformity between sandstone and limestone. On the other hand, the effect is not significant over a fairly wide range of sandstones. This indicates that the sandstones studied (and perhaps in general) are statistically relatively uniform as far as this mechanism is concerned.

In laboratory sand packs we see formation of "fingers" of the displacing phase penetrating into the displaced phase. The more adverse the mobility ratio, the more pronounced the fingering. Likewise, the more nonuniform the sand pack, the more pronounced the fingering. It would appear that there are two factors contributing to fingering in the reservoir: (1) Instability of displacement because we are pushing a more viscous material with a less viscous material, and (2) nonuniformity. Shell[17] and Humble[16] laboratories and others are doing some research on unstable systems. Since it is impossible to build an absolutely uniform system for laboratory experimentation, these laboratories are using a mathematical approach. We at Atlantic and others have done some work on fingering as affected by the other factor, nonuniformity. In the reservoir both these factors are present and we need to know how they combine.

C. A. Hutchinson, Jr. presently supervises the Reservoir Mechanics Group of the Research and Development Department, The Atlantic Refining Company, Dallas. He obtained a BS and MS in chemical engineering and a BS in electrical engineering from the University of Colorado. He served as Lt. (jg) with the Navy during World War II. From 1946 to 1949 he was on the faculty of the University of Colorado in the Applied Mathematics Department and the Engineering Experiment Station. He joined the Research and Development Department of Atlantic in January 1949, and has been there since in various capacities including research in Reservoir Mathematics and Engineering, Operations Research and Project Evaluation, and Reservoir Mechanics.

Stratified Formations

Perhaps the best known (but not necessarily best defined) type of gross reservoir inhomogeneity is stratification. In his 1927 paper on theoretical aspects of waterflooding, Lester C. Uren[18] discussed possible significance of this nonuniformity. There has been much discussion and numerous papers on the subject since, but even in this limited area our knowledge is poor.

The origin of layered beds is covered simply by Levorsen[19] in *Geology of Petroleum* as well as by many others. In these works we find that a single stratum may be field-wide and traceable from well to well. In other instances the stratum apparently pinches out and becomes discontinuous. In addition, the physical characteristics of a layer may vary from location to location. Indeed, the definition of a specific stratified system is no minor problem. From the reservoir engineering standpoint we are faced with the same two problems that are inherent in all consideration of reservoir inhomogeneities: (1) What is it, and (2) what does it do to us?

Determination of strata. Our first step now is to look at present methods for defining stratified reservoirs. The reservoir engineer is really "grasping for straws" in doing this. He uses well logs, core analysis, and at times production and injection profiles. Log and core data will give the engineer a fairly good picture of stratification in the small area sampled (1/10 sq ft for cores and slightly greater for logs). If strata so found in one well can also be found in adjacent wells, we feel fairly confident (but not sure) of what the formation is like in between the wells. If we cannot trace the strata from well to well, we really have no idea of what the formation is like between wells. In short, unless the system is homogeneously inhomogeneous we are taking much too small a sample to tell anything about it. For example, on 80-acre development with cores taken at every well (unusual indeed) we would sample only 0.00000003 of the reservoir. No wonder we have trouble!

This immediately points out a frontier of reservoir technology. How are we going to find out more about the relatively simple reservoir inhomogeneity of stratification? One method that is presently being studied is close examination of very recent marine sediments[20] to see what might be expected in our formations. Perhaps we can glean more information from production and injection characteristics of wells and from bottom-hole pressure build-up studies.

Assuming that our reservoir is stratified and we have been able to describe the stratification, the problem becomes one of ascertaining what this stratification does to us. And this, in turn, we immediately conclude is dependent

upon what we are doing to the reservoir. It should be readily apparent that stratification will affect waterflooding differently than it does solution gas depletion.

There has been some publication[21,22,23] on reservoir engineering methods to predict performance of a stratified reservoir. Perhaps the best known is the "Stiles method."[24] This appears to be a method involving the use of approximately compensating errors since it is reported to give a fair approximation of waterflooding performance. The method is based (knowingly) on several impossible assumptions and partially neglects the important influence of mobility ratio and cross flow. Some comparisons of this method with a more rigorous (but not complete) analysis have been presented by Dyes and Braun.[25] These last words are not in condemnation of engineers trying to develop useful methods. They are more in sympathy. The problem has been too tough for our present state of knowledge. This is apparent as we look further into possible effects of stratification.

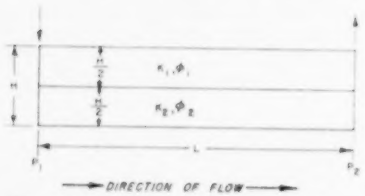


FIG. 6. Idealized model of stratified linear system is used to analyze fluid flow through a stratified reservoir.

Typical stratified system. Let us consider a specific (and simple) stratified system and see what problems arise. Assume a linear system L ft in length, H ft thick, and with two strata of equal thickness, H/2. The upper stratum has a permeability K_1 and porosity ϕ_1. The lower stratum has values of K_2 and ϕ_2. This system is shown in elevation in Fig. 6.

If there is a permeability barrier between these two strata, the problem can be reduced to analysis of two separate homogeneous formations. The same pressure drop will be across each. Let us now assume $K_1 = 5.4\,K_2$. At breakthrough from the more permeable stratum only a fraction of the less permeable stratum is swept. This fraction depends upon the mobility ratio and, to a lesser extent, upon the porosity ratio. This dependence upon mobility ratio is shown in Fig. 7, from which it can be seen that there is significant advantage in the favorable (<1) mobility ratios.

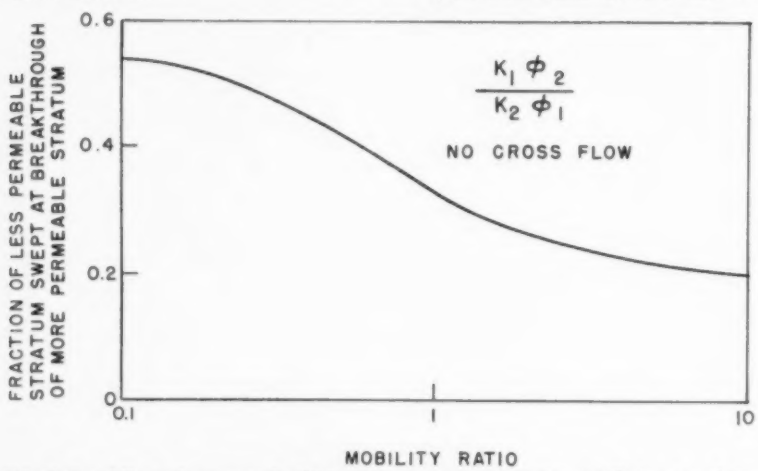


FIG. 7. Breakthrough sweepout efficiency in a noncommunicating stratified system shows the advantage of favorable mobility ratios, i.e., MR < 1.

Inter-strata forces. If there is no permeability barrier between the strata, the problem becomes more complex. One or more of three forces may develop a vertical pressure gradient which will cause flow between the strata. These are gravity, capillary, and viscous forces. Suppose we water flood this system and the more permeable layer is on top. Water will travel down the top layer more rapidly than the bottom, and at the flood front we have water flowing over oil. Gravity will want to reverse this situation since the water is heavier than oil. There is a vertical pressure drop caused by gravity and the density difference. This results in cross flow between the strata. In addition, if this is a water-wet system, there will be capillary forces seeking to have the water in the more advanced front imbibe into the less permeable layer — another cross flow process. The third cause of cross flow is the vertical gradient resulting from viscous pressure drops in the reservoir. This is a less obvious process and not as subject to analytical solution.

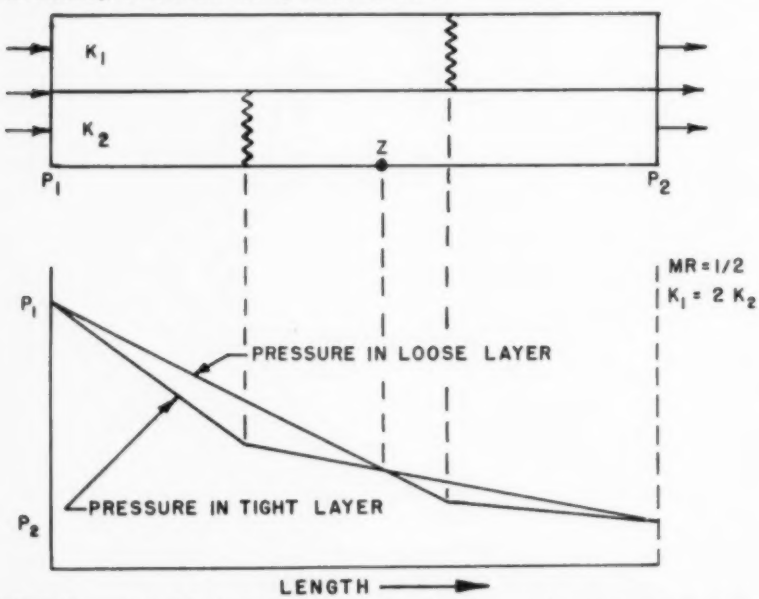


FIG. 8. Pressure profiles in stratified linear system show the vertical pressure gradients which cause cross flow between communicating strata.

In a linear system such as our model, if we give the displacing and displaced phases equal mobilities, we know that the pressure gradient is constant at $(P_1 - P_2)/L$ psi/ft. However, if the displacing phase is more viscous than the displaced phase (or vice versa), the pressure gradient is no longer constant. For example, let us take a mobility ratio of ½ (favorable), i.e., the displacing phase is the less mobile material. Pressure gradient in the displacing phase will be two times that in the displaced phase. This assumes equal velocities or no cross flow and equal relative permeabilities. Pressure profile of our linear system for these

conditions is depicted in Fig. 8. In this figure we can see that pressure in the more permeable layer (layer 1) left of point Z is greater than the pressure in the less permeable layer. The reverse is true to the right of point Z. Thus, there are vertical pressure gradients to cause cross flow. Cross flow will have an effect on sweepout efficiency, and our problem is to find what effect and how significant it is.

The problem could be approached either as a complicated computational problem or as an experimental modeling problem. We chose the latter and constructed consolidated sand scaled models with stratification present. This technique is the same as was used in areal sweepout studies in which we examined flow by the X-ray.[26,27] Parameters investigated were:

K_1/K_2, permeability ratio of layers,
MR, mobility ratio,
L/H, length to height ratio of system,
h_1/h_2, ratio of thicknesses of layers.

The study is still in progress and has not been extended yet to systems of more than two layers or to radial or pattern systems. However, we can report some interesting findings on the linear two layer system:

1. Effect of L/H
   Range studied: 0 to 15
   Conclusion: There is no measurable effect of L/H except for thick, short systems where L/H <2. This condition will not be found in the field.
2. Effect of h_1/h_2
   Range studied: ⅓ to 3
   Conclusion: If L/H >2, there is no effect of h_1/h_2 over the range studied.

Parameters K_1/K_2 and MR are the significant factors setting the amount of cross flow. We studied K_1/K_2 from 1 to 8.5 and MR from 1/10 to 10. Results of these studies are presented in Fig. 9. In this figure we show the breakthrough sweep efficiency with cross flow as a fraction of the sweep efficiency without cross flow related to the mobility ratio and the conductivity ratio $(K_1\phi_2)/(K_2\phi_1)$. Porosity ratio, ϕ_2/ϕ_1, has been incorporated with K_1/K_2 to form a conductivity ratio which is the fundamental basis for linear advance of a front.

One immediate observation from Fig. 9 is that there is an insignificant cross flow effect for the unfavorable (>1) mobility ratios. Thus, we can calculate reservoir performance on the basis of noncommunicating sands when the mobility ratio is one or greater (unfavorable). There is a pronounced effect of cross flow at the favorable mobility ratios. This, of course, must be taken into account by the reservoir engineer.

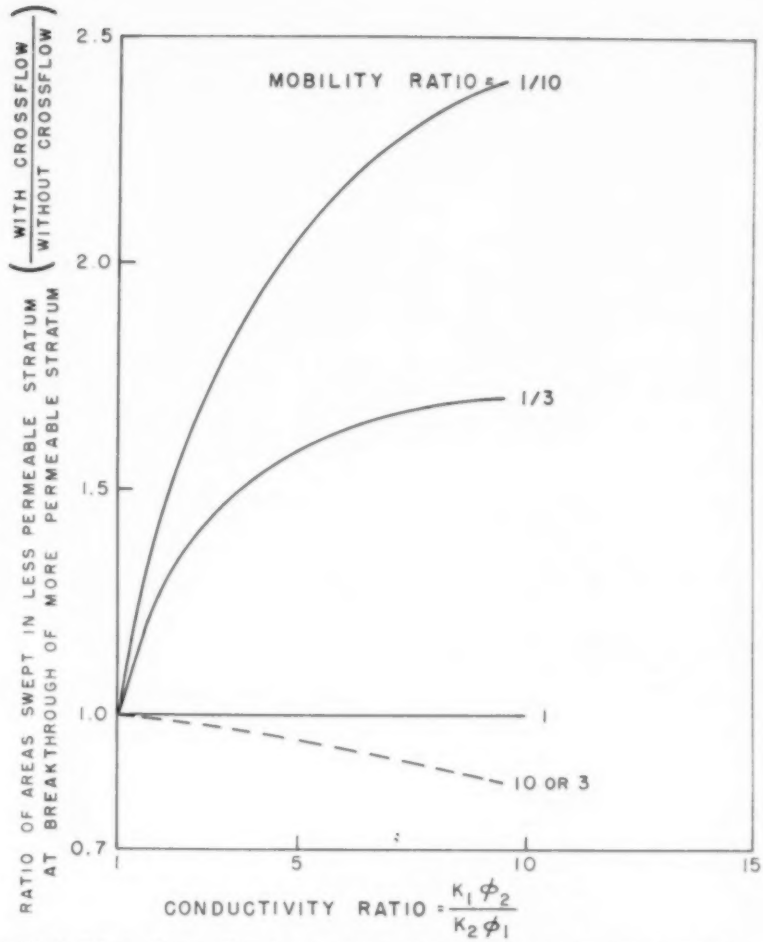


FIG. 9. Effect of cross flow in a two-strata system is shown as a function of conductivity ratio and mobility ratio. Results shown in this graph are preliminary.

Stratification and cross flow have significance in the miscible slug process. In this process a small band of solvent is injected to miscibly displace the oil. Solvent is then miscibly displaced by gas. It is imperative that sufficient solvent remain between the oil and gas. Effect of stratification is felt immediately in this process. For example, in a two-strata system with a permeability ratio of 10, 10/11 of the solvent will be injected into the more permeable layer and only 1/11 into the less permeable layer. (This is on an equal layer thickness basis.) Thus, to put enough solvent in the tight layer, we must put 10 times "enough" in the more permeable layer. This hurts because that solvent is expensive.

Once we get our solvent bank into the tight layer will it stay there, or will it cross-flow out? Another hazard reported by some is that the solvent in both layers is more subject to dissipation by diffusion because of more area open for diffusion to be effective. We have briefly looked at the cross flow problem by a model study. Here we found that the solvent bank stays where it is supposed to be and does not cross flow into other strata. The diffusion problem is yet to be answered to our satisfaction.

Inasmuch as favorable (<1) mobility ratios lead to not only better vertical sweepout neglecting cross flow but also lead to favorable cross flow effects, a recovery process is immediately suggested. Let us make our displacing phase more viscous than the displaced phase, or some other approach to change the mobility ratio.

Stratification, besides being a headache, may be a blessing in disguise from another standpoint. In an injection process when the injected fluid is heavier or lighter than the displaced fluid there is a gravity segregation tendency. This, of course, results in lowered sweep efficiency. This tendency is greater in thick sands. Stratification helps in this instance in making a number of thin sands not so subject to gravity segregation.

Another process significantly affected by stratification is in-situ combustion.

In their Oklahoma test of the process, Magnolia reported only a central high permeability layer was burned.[28] If we know stratification is present and know its effect, such as in this burning test, there must be some way for us to engineer to account for or perhaps take advantage of this effect.

Anisotropic Horizontal Permeability

Many operators feel it desirable first to test a waterflooding operation by a pilot flood of the formation. This would seem to be reasonable, especially if there are uncertainties about the floodability of the formation. This was the approach used in the start of a major flood in the North Burbank field, Osage County, Oklahoma.[29,30] This is a fairly big field with about 20,000 productive acres. Thus, a big pilot program was undertaken. A 90-acre pilot plot was selected and infill wells were drilled to give 10 acres per 5-spot pattern rather than the field-wide 20 acres per 5-spot. This closer spacing was chosen to give an earlier evaluation of pilot performance. The pilot area then consisted of 9 injection wells in a 5-spot array. A plot is shown in Fig. 10.

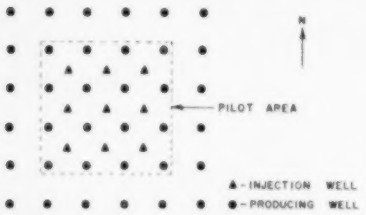


FIG. 10. Pilot flood area in a North Burbank field project consisted of 9 injection wells in a 5-spot array.

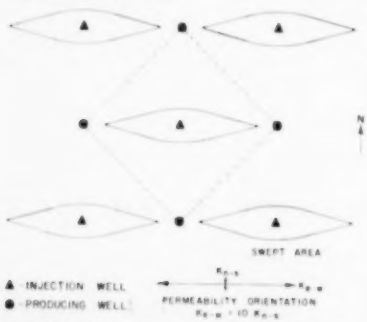


FIG. 11. Unfavorable permeability orientation in a 5-spot flood system illustrates the unfortunate effects of anisotropic horizontal permeability.

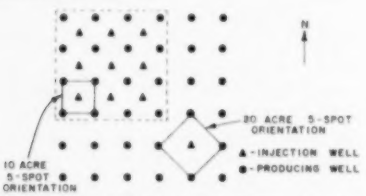


FIG. 12. Shift in 5-spot array with increased spacing changes the relative direction of the oriented permeability.

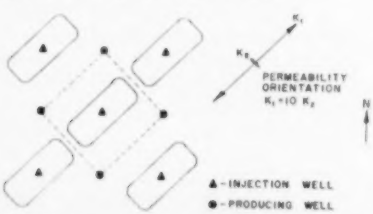


FIG. 13. Favorable permeability orientation for a 5-spot system will result in a very efficient sweepout process.

Directional permeability. We can learn much from such experiences, especially when we couple this field experience with data from laboratory flooding tests. The problem at North Burbank was a naturally oriented fracture system with fractures running east and west. In the reservoir horizontal permeability was much greater in the east-west direction than in the north-south direction. This is one case of anisotropic horizontal permeability.

Imagine a formation that is 10 times as permeable in an east-west direction as it is in the north-south direction. Anything we inject into this formation will find it easier to move in the east-west direction and will do so. It turns out that it will not move east and west 10 times faster than north and south, but $\sqrt{10}$ times faster. This would lead to sweepout patterns which are generally oriented as shown in Fig. 11.

In this figure we can see that water will break through rapidly at all producers without sweeping much of the reservoir. This was the general problem at North Burbank. Why didn't this happen in the pilot test? The answer is now very simple. Because infill wells were drilled to make closer spacing for early pilot evaluation, the relative direction of the oriented permeability was changed. This shift is shown in Fig. 12. Fig. 13 depicts example sweepout for permeability orientation shifted 45 deg, which was the shift made in changing from the 10 acre to 20 acre 5-spot. Note that we will have a very efficient sweepout process. Injected water tends to move toward another injection well. The waters from two wells approach each other, interfere, and then move toward the producing wells.

Our laboratory undertook some model studies to find what we should expect in 5-spot pattern floods with oriented permeability. Important factors are mobility ratio, permeability ratio, and azimuth of permeability orientation.

The study method was the same as used for the pattern sweepout work. This has been covered in an earlier presentation by B. H. Caudle.[26] One different condition exists in this model study. We had to put in permeability that varied with direction. This is practically a physical impossibility, and tests

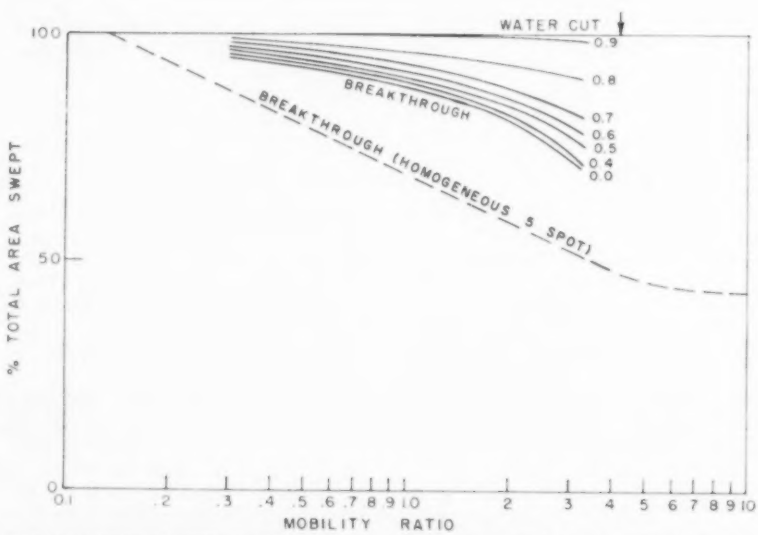


FIG. 14. Sweepout pattern efficiency in a 5-spot pattern of anisotropic horizontal permeability. The most favorable arrangement has the direction of maximum permeability parallel to lines through injection wells, as illustrated here.

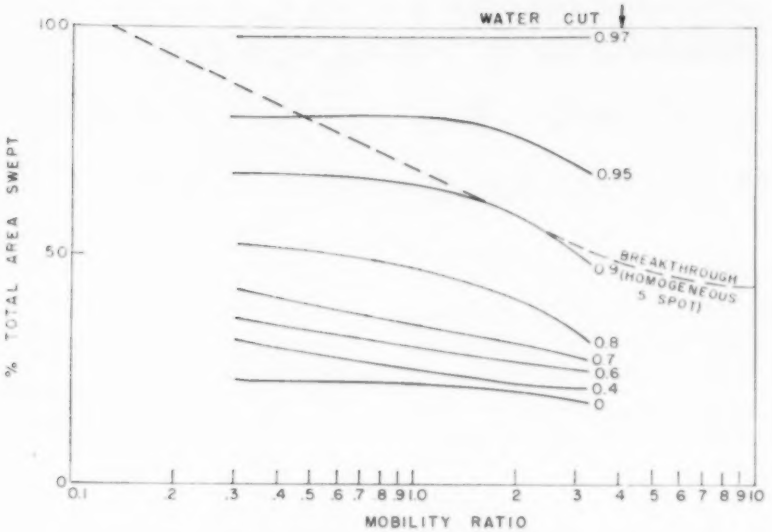


FIG. 15. Sweepout pattern efficiency in a 5-spot pattern operating under the least favorable arrangement, i.e., with the direction of maximum permeability parallel to a line from an injection well direct to a producing well.

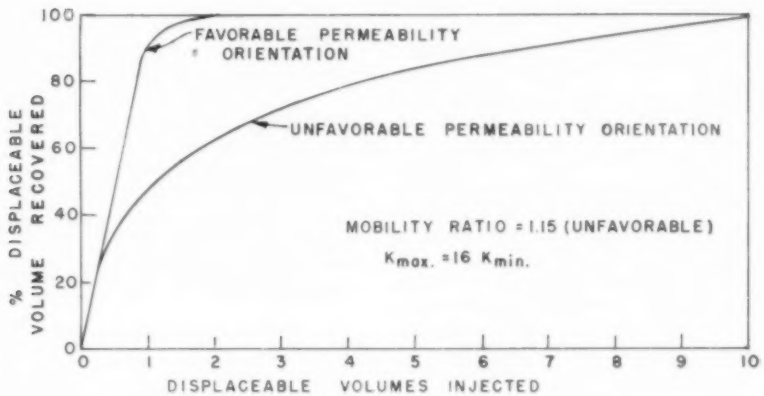


FIG. 16. Effect of permeability orientation on oil recovery in a 5-spot system.

were made on uniform models distorted to represent this permeability orientation. This system has been proved mathematically rigorous and has been used frequently. Results of this study are shown in Fig. 14 and 15. Sweepout efficiency has been plotted at various stages of the flood of a 5-spot system from breakthrough to high water-cut production as a function of mobility ratio. This is compared to pattern sweepout efficiency at breakthrough for a homogeneous system. Permeability ratio here was 16. For Fig. 14, permeability was oriented in the most favorable direction, i.e., direction of maximum permeability was parallel to lines through injection wells.

Fig. 15 shows the same plot except that the permeability orientation has been shifted 45 deg such that the direction of maximum permeability was parallel to a line from an injection well direct to the producing well. This is the most unfavorable condition.

Perhaps a more dramatic presentation of these conditions can be made by comparing production curves for a 5-spot system with permeability orientation (1) most favorable, and (2) most unfavorable. This is done in Fig. 16. In this example, permeability ratio is 16 and mobility ratio is 1.15 (unfavorable). This mobility ratio is reasonable for many water floods.

If anisotropic horizontal permeability conditions do exist in a reservoir that we plan to flood (or any other injection operation), the difference between profit and loss could be direction of orientation. We cannot change the direction of orientation, but we can change its relative direction as far as our 5-spot pattern is concerned. This is why the North Burbank story has a happy ending. Once the trouble was recognized, it was only necessary to shift pattern to shift from failure to success.

Orientation methods. How do we find out whether or not our reservoir has oriented permeability? There are several approaches. We can look first to core analysis. It is a relatively simple matter to perform "whole core" analysis. This involves special core holders. Horizontal permeability is measured on short, 6 in. to 1 ft, pieces of core. We can find directional permeability by measuring permeability on this "whole core" several times, each time rotated 45 to 60 deg in the core holder.[35] This will tell us if directional permeability exists in the core pieces being analyzed. If oriented permeability is present in the pieces of core so analyzed, we want to know whether the maximum permeability in each core piece is oriented in the same direction in the well. This is also relatively simple if a little foresight is used.

In our limited testing to date we have found that if oriented permeability does exist it has the same orientation vertically through the reservoir. So far we have not discussed how to get true permeability orientation in the reservoir. This involves a core orientation procedure so that when the core arrives at the derrick floor we can tell how it was oriented in the hole before it was broken off. Basically the technique is to place a nonmagnetic sub in the drill string. In this sub is a compass card that is marked just before the core leaves the bottom of the hole. The core is then oriented with respect to this compass card.

Another possibility of core orientation is measurement of the core residual magnetism. We have not been successful with this method. A third possibility for core orientation is by analysis of formation dip. If the formations have a dip and direction of dip is known, this can be matched to dip in the strata of the core.

Another general anisotropic permeability detection and orientation procedure is to pilot-flood the reservoir on an inverted 9-spot pattern as shown in Fig. 17. After accounting for different distances to the production wells and different production rates at these wells, we can identify permeability orientation, its azimuth, and permeability ratio by times of breakthrough at the various wells.

Are we fighting a "straw man" in worrying about oriented permeability? I think this may well be the case in normal sand reservoirs. Some orienta-

tion of permeability has been found in these reservoirs but the permeability ratio is too low (about 2) for concern.[31] However, the fractured sands and the limestones with vugs, solution channels and fractures have been shown to have permeability ratios at times very significant.[32, 33] We have tested about 10 limestone formations and found oriented permeability of significant permeability ratio in about half the cases. Average permeability ratio was about 16 which was the basis for choosing this number in the preceding illustrations. Another excellent example of fractured sandstone with oriented permeability is the Spraberry field of West Texas.[34]

An interesting point involving oriented permeability concerns formation stratification analysis. When permeabilities from core plugs are used to evaluate stratification, we may be misled since the plugs are generally taken in random direction. If permeability orientation does exist, we will be at least in part measuring permeability ratio and not entirely stratification by use of plug analysis.

Other Gross Reservoir Inhomogeneities

We have long been aware of another type of anisotropic permeability where there is a difference between vertical and horizontal permeability. This is well demonstrated in core analysis. However, a description of this condition reservoir-wide has evaded us. Samples of the reservoir that we get in cores are too small. Permeability is a statistical proposition and a core sample may well not be of sufficient lateral dimension to give a meaningful answer.

Lenses. Production people are generally optimists, but not where reservoir inhomogeneities are concerned. A frequent answer to questions of what might be expected is that we should imagine the worst thing possible and the reservoir will "do us one better." Much of the discussion on reservoir inhomogeneity is purely from speculation and there is little or no evidence of what gross inhomogeneities really exist. Uren[18] in 1927 drew pictures of fine grained lenses residing in coarse grain reservoirs. Clark[36] in 1957 proposed a process to better sweep these lenses in secondary recovery. The apparent feeling is that the lenses are relatively small since it is proposed to displace oil by water imbibition from the lens while the front moves past the lens in the coarse sand. Do these exist? We do not see them on ocean beaches.

This is only one example from many postulated reservoir inhomogeneities. It would appear that the course of action for the future should have as a main objective the identification and description of reservoir inhomogeneities so that we will not have to rely on fear and hypothesis.

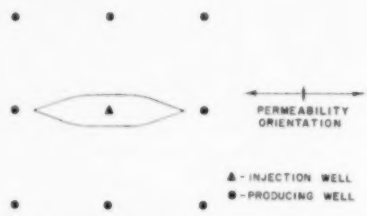


FIG. 17. Inverted 9-spot pilot can be used to determine permeability orientation, its azimuth, and permeability ratio by times of breakthrough at the various wells.

This discussion of reservoir inhomogeneities has not been designed to strike fear into the heart of engineers and management who consider injection processes. There is documented evidence that injection processes can succeed. Fortunately, the reservoir engineer is capable of estimating effects of inhomogeneities in many cases. He presently must rely on judgment and empirical experience for much of this estimation. The pilot injection program can also be used to remove doubt as to the workability of an injection program. These approaches are not infallible and management must take a calculated risk in approving the projects.

Technical advances in the study of reservoir inhomogeneities will lead to better predictions of reservoir performance with fewer failures in injection operations. These advances will also lead to methods by which we can at least partially overcome the adverse effects inherent in an inhomogeneous system. For example, this is the basis for use of a more viscous injection fluid to mitigate stratification effects. Most certainly, as we learn more about what reservoir inhomogeneities exist, we will be able to better design our injection operations.

References

1. Levorsen, A. I. — *Geology of Petroleum* — W. H. Freeman and Company, San Francisco, (1956) p. 51.

2. Dowell Advertising. For example, see inside front cover of *The Petroleum Engineer*, February, March, and June, 1958.

3. Kimbler, O. K. and B. H. Caudle — "An Enlargement Technique for the Semimicroscopic Study of Fluid Flow and Phase Distributions in Porous Media" — Paper No. 21, AIChE Meeting, Houston, May 3, 1955.

4. Chatenever, A. and J. C. Calhoun — "Visual Examination of Fluid Behavior in Porous Media — Part I" — Trans AIME, 195 (1952) p. 149.

5. Jordan, J. K., W. M. McCardell and C. R. Hocott — "Effect of Rate on Oil Recovery by Water Flooding" — Humble Oil and Refining Company Publication, August 1, 1956 (Revised).

6. Moore, T. F. and R. L. Slobod — "The Effect of Viscosity and Capillarity on the Displacement of Oil by Water" — *Producers Monthly*, August 1956, p. 20.

7. Griffiths, J. C. — "Grain Size Distribution and Reservoir Rock Characteristics" — Bull. AAPG, 36, No. 2, February 1952, p. 205.

8. Stewart, C. R., F. F. Craig, Jr., and R. A. Morse — "Determination of Limestone Performance Characteristics by Model Flow Tests" — Trans AIME 198 (1953) p. 93.

9. Bulnes, A. C. and R. U. Fitting, Jr. — "An Introductory Discussion of the Reservoir Performance of Limestone Formations"—Trans AIME, 160 (1945) p. 179.

10. MacCaffray, S. A. — "A Study of the Interrelation of Porosity, Permeability, and Grain Size in a Consolidated Porous Medium"—Thesis, MS, University of Pittsburgh.

11. Burdine, N. T., L. S. Gournay and P. P. Reichertz — "Pore Size Distribution of Petroleum Reservoir Rocks" — Trans AIME, 189 (1950) p. 195.

12. Nuss, W. F. and R. L. Whiting — "Technique For Reproducing Rock Pore Spaces" — Bull AAPG, 31, November 1947, p. 2044.

13. Purcell, W. R. — "Capillary Pressures — Their Measurement Using Mercury and the Calculation of Permeability Therefrom" — Trans AIME, 186 (1949) p. 39.

14. Drake, L. C. and H. L. Ritter — "Pore Size Distribution in Porous Materials" — *Industrial and Engineering Chemistry* (Anal. Ed.) 17, (1945) p. 782.

15. Handy, L. L. — "An Evaluation of Diffusion Effects in Miscible Liquid Displacement" — Paper 1130-G, AIME Fall Meeting, Houston, October 5-8, 1958.

16. Terry, W. M., R. J. Blackwell and J. R. Rayne — "Factors Influencing The Efficiency of Miscible Displacement" — Paper No. 1131-G, AIME Fall Meeting, Houston, October 5-8, 1958.

17. Chouke, R. L., P. van Meurs and C. van der Poel — "The Instability of Slow, Immiscible, Viscous Liquid-Liquid Displacements in Permeable Media" — Paper No. 1141-G, AIME Fall Meeting, Houston, October 5-8, 1958.

18. Uren, Lester C. — "Increasing Oil Recovery by Flooding" — *National Petroleum News*, August 3, 1927, p. 50.

19. Levorsen, A. I. — *Geology of Petroleum* — W. H. Freeman and Company, San Francisco, (1956) p. 59.

20. API Project 51 — "Study of Near-Shore Sediments and Their Environments in the Northern Gulf of Mexico."

21. Stahl, C. D. — "Consideration of Unequal Flood Advance in Stratified Systems" — *Producers Monthly*, March 1958, p. 4.

22. Hauber, W. C. — "The Utilization of a Fluid Model to Predict Waterflood Behavior In A Formation Having Permeability Stratification" — MPE Thesis, University of Oklahoma.

23. Muskat, M. — "The Effect of Permeability Stratification in Cycling Operations" — *Journal of Petroleum Technology*, November 1948.

24. Stiles, W. E. — "Use of Permeability Distribution in Waterflood Calculations" — Trans AIME, 186 (1949) p. 9.

25. Dyes, A. B. and P. H. Braun, — Sweepout Patterns in Depleted and in Stratified Reservoirs" — *Producers Monthly*, December 1954, p. 24.

26. Caudle, B. H.—"Injection Pattern Sweepout Efficiency"—*The Petroleum Engineer*, June 1959, p. B-34.

27. Slobod, R. L. and B. H. Caudle — "X-Ray Shadowgraph Studies of Areal Sweepout Efficiencies" — Trans AIME, 195 (1952) p. 265.

28. Kuhn, C. S. and R. L. Koch — "In-Situ Combustion" — *Oil and Gas Journal*, August 10, 1953, p. 92.

29. Hunter, Z. Z. — "8½ Million Extra Barrels in 6 Years" — *Oil and Gas Journal*, August 27, 1956, p. 86.

30. Hunter, Z. Z. "Progress Report, North Burbank Unit Water Flood — January 1, 1956" — *API Drilling and Production Practice*, (1956) p. 262.

31. Fettke, C. R. — "The Bradford Oil Field, Pennsylvania and New York" — *Pennsylvania Geological Survey 4th Series, Bulletin M21*, (1938).

32. Hutta, J. J. and J. C. Griffiths — "Directional Permeability of Sandstones" — *Producers Monthly*, September 1955, p. 26 and October 1955, p. 24.

33. Johnson, W. E., and R. V. Hughes — "Directional Permeability Measurements and and Their Significance" — Proceedings 12th Technical Conference on Petroleum Production, *Mineral Industries Experiment Station* Bulletin No. 52, The Pennsylvania State University, (1948) pp. 180-205.

34. Brownscombe, E. R. and A. B. Dyes — "Water Imbibition Displacement A Possibility For the Spraberry" — *Oil and Gas Journal*, November 17, 1952, p. 64.

35. Kelton, Frank C. — "Analysis of Fractured Limestone Cores" — Trans AIME, 189 (1950) p. 225.

36. Clark, Norman J., G. M. Andreen and A. J. Wessely — "Miscible Displacement With A Frontal Water Bank Is Latest Oil Recovery Idea" — *The Petroleum Engineer*, September 1957, p. B-21.

★ ★ ★

Volume Variations of Underground Storage Reservoirs

Underground oil or gas storage reservoirs surrounded by or adjacent to an aquifer experience considerable volume variations. Here are two methods of predicting these changes

H. D. Yoo, D. L. Katz, R. R. White, and M. R. Tek
Dept. of Chemical and Metallurgical Engineering
University of Michigan, Ann Arbor, Michigan

PRESSURE-VOLUME VARIATIONS occurring in natural gas reservoirs converted to storage operations are of interest from the standpoint of both the long range economics of gas storage operations and the short range interpretation of reservoir engineering data.

A large number of gas producing sands eventually converted to gas storage use occur with fluid communication with a large water-bearing formation, or aquifer, surrounding or underlaying the gas reservoir. As the pressure in the gas bubble adjacent to the aquifer changes by a cyclic variation due to seasonal injection and withdrawal of the natural gas, the motion of the aquifer-gas interface causes the net volume available for gas storage to fluctuate. Consequently, the pressure-volume behavior of the gas reservoir subjected to water drive is, in general, governed by the average pressure within the gas reservoir, compressibility of the gas and expansibility of the aquifer fluid, and the physical properties of both the gas-bearing sand and the surrounding aquifer formation. A theoretical prediction of the water movement in and out of the gas storage reservoir and an empirical method to correlate the current net storage volume to reservoir pressure-production data have been the main objectives of this study.

Theoretical Method

The model considered in the following discussion is indicated in Fig. 1.

The gas reservoir, R, is sitting and breathing on a horizontal, infinitely large aquifer saturated by compressible brine. If permeability, porosity, viscosity of brine, and compressibility of brine are assumed constant, if the blanket sand is not thick enough to give excessive vertical pressure distribution, and if there is no fault in the aquifer, the flow of brine through the porous medium can be described by the following differential equation which is commonly called the "radial diffusivity equation."[1,2,3,4] (All symbols used in this paper are defined in the Nomenclature at the end of the article.)

$$\frac{\delta^2 P}{\delta r^2} = \left(\frac{1}{r}\right)\frac{\delta P}{\delta r} = \left(\frac{c\phi\mu}{k}\right)\frac{\delta P}{\delta \Theta} \quad . \quad . \quad (1)$$

or

$$\frac{\delta^2 P}{\delta r_D^2} + \left(\frac{1}{r_D}\right)\frac{\delta P}{\delta r_D} = \frac{\delta P}{\delta t_D} \text{ (in dimensionless form)} \quad . \quad . \quad (2)$$

In order to find out how much brine has come in or moved out of a gas reservoir at any time, the partial differential equation must be solved with these boundary conditions:

1. Initially, the pressure in the aquifer was uniform at the discovery pressure:

$$P(r_D, O) = 0, \text{ or constant} \quad . \quad . \quad . \quad . \quad (3)$$

2. At any time the pressure at a distance far away from the gas reservoir is constant and equal to the discovery pressure:

$$P(\infty, t_D) = 0 \quad . \quad . \quad . \quad . \quad . \quad (4)$$

3. Average reservoir pressure is given as a function of time:

$$P(1.t_D) = G(t_D) \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The solution of Equation 1 with the boundary conditions established in Equations 3, 4, and 5 can be sought by the use of an RC type or electronic analog computer, or a digital computer.[5] The solution can also be obtained by applying the constant terminal pressure case given by

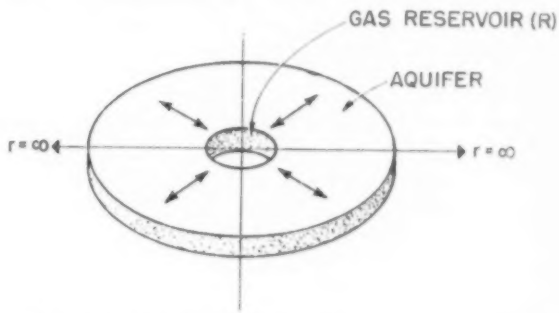


FIG. 1. Idealized radial flow model of a gas storage reservoir surrounded by an aquifer of infinite radius.

Hurst and Van Everdingen through the use of superposition principle.

In applying the Laplace Transformation technique to the boundary value problem described above, for the given time-varying boundary conditions, the following equation is derived. (Details of the derivation are given in Appendix A.)

$$Q_{t_D} = \int_0^{t_D} \left(\frac{\delta P}{\delta r_D}\right)_{r_g} dt_D =$$

$$\int_0^{t_D} \left[\frac{dG(\tau)}{d\tau}\right] \cdot Q'_{t_D}(t_D - \tau)\, d\tau \quad . \quad . \quad . \quad . \quad . \quad (6)$$

or

$$= \int_0^{t_D} \left[\frac{dG(t_D - \tau)}{d\tau}\right] \cdot Q'_{t_D}(\tau)\, d\tau$$

Equation 6 is a solution to Equation 2 with any sectionally continuous arbitrary pressure function of which the Laplace

transform exists. If the arbitrary function $G(t_D)$ is sinusoidal, Equation 6 can be further reduced to more convenient form from which some useful deductions can be made. The cumulative influx or efflux for sinusoidal pressure variation is given by Equation 7:

$$\text{If } G(t_D) = P_o \sin \omega t_D,$$

then

$$Q_{t_D} = \omega \int_0^{t_D} P_o \cos \omega(t_D - \tau) \cdot Q'_{t_D}(\tau)\, d\tau \quad . \quad . \quad (7)$$

This equation can be written in another form:

$$Q_{t_D} = P_o \omega \cos \omega t_D \int_0^{t_D} \cos \omega\tau \cdot Q'_{t_D}(\tau)\, d\tau +$$

$$P_o \omega \sin \omega t_D \int_0^{t_D} \sin \omega\tau \cdot Q'_{t_D}(\tau)\, d\tau \quad . \quad . \quad (8)$$

Equation 8 shows that harmonic pressure operation does not result in a simple harmonic influx or efflux function. A detailed example follows.

Application: Volume Variation Of a Gas Storage Reservoir

A nearly depleted oil field has been suggested for underground gas storage operation. A study of the ability of the gas pressure to return the water to the aquifer sand is proposed. From the past production-pressure data, the amount of water which can be pushed out of the reservoir may be calculated in order to determine the gas storage capacity. If the approximate initial oil in place is estimated by the usual methods of reserve calculations,[6] one can evaluate water influx from production, solubility, and formation volume factor data. By making a material balance of total gas, one can arrive at the following cumulative water influx equation:

$$W = \Delta N \left[5.61B + v(R' - S) \right] - N \left[5.61B + (S_o - S)\, v - 5.61B_o \right] \quad . \quad . \quad (9)$$

The procedure to predict cumulative water influx (see Table 1) is:

1. From the production data, calculate cumulative water influx at any time in the past using Equation 9. Calculated results by material balance are tabulated in the third column (Table 1). A sample calculation of cumulative influx by Equation 9 is included in Appendix C.

TABLE 1. Comparison Between Predicted and Observed Water Encroachment.

Time — year	Pressure — psig	Cumulative Influx by Material Balance — Mm cu ft	Cumulative Influx — Theoretical — Mm cu ft
1941	1320	1.27	1.24
1944	610	34.00	34.40
1948	365	92.00	98.50
1952	370	145.00	158.00
1954	420	187.00	180.00
1955	460	175.00	190.00
1956	500	237.00	208.00
1957	525	—	218.00

2. Estimate the geological properties of the aquifer sand. This is done by trial and error. Theoretical cumulative influx determined upon integrating Equation 6 graphically by assuming the values of the geological properties as selected below gives the theoretical cumulative influx tabulated in the fourth column, to match the values in the third column. It must be pointed out that the use of Equation 9 is restricted for a depleted oil, not gas, reservoir.

   Geological properties:

   $k = 0.18$ darcy
   $c = 4.4 \times 10^{-5}$ (vol) / (vol) (atm)
   $\phi = 0.2$
   $\mu = 0.4$ cp
   $h = 7$ ft
   $r_g = 2.46 \times 10^5$ cm

3. Once reservoir properties are adequately estimated to match observed data as outlined in Step 2, predictions of future reservoir performance can be made. With a proposed pressure variation, an estimate of cumulative water influx can be made by integrating Equation 6 the same way as in Step 2. The calculated results for the example problem are tabulated in Table 2.

The details of graphical integration of Equation 6 and a typical set of numerical calculations are included in Appendix B.

TABLE 2. Prediction of Future Net Water Encroachment.

Date	Proposed Pressure — psig	Cumulative Influx — Predicted — Mm cu ft
Mar 1958	535	222.0
Oct 1958	1700	216.5
Mar 1959	1700	214.2
Apr 1959	2000	213.8
Dec 1962	2000	188.7
Dec 1964	2000	171.5
Dec 1968	2000	111.0
Dec 1970	2000	65.7

Care must be taken in integrating Equation 6 to obtain cumulative influx function Q_{t_D}. The authors have integrated Equation 6 graphically by plotting pressure (psi) or $G'(\tau)$ versus the dimensionless quantity $Q'_{t_D}(t_D - \tau)$ and obtaining the appropriate areas according to Equation 6. The net area bounded by the curve and the discovery pressure line is the cumulative influx or efflux function. The area bounded below the discovery pressure line is the influx, and the area bounded above the discovery line is the efflux. The algebraic sum is the cumulative influx or efflux function. The cumulative influx or efflux can be calculated from the following equation with the cumulative influx function obtained as described above:

$$W = 2\pi\phi c' r'^2_g h Q_{t_D} = 1.72 \times 10^3\, Q_{t_D} \quad . \quad . \quad . \quad . \quad . \quad (10)$$

For instance, the cumulative influx function is 126,000 for October 1958, which gives:

$$W = (1.72 \times 10^3)\ (126{,}000) = 216.5 \times 10^6 \text{ cu ft}$$

Empirical Correlation Method For Depleted Gas Reservoirs

In order to find an empirical means to predict the water movement in and out of the gas sand, some sort of trend was to be found in correlating the available production-pressure data in terms of important variables. Such a correlation may then be used in predicting the future performance of a gas reservoir. The important variables selected for the correlation are the pressure level, rate of pressure change, and the rate of reservoir volume change. Fig. 2 and 3 are examples of such a correlation. In preparing these charts, the differential quantities for volume and time were obtained numerically. The detailed procedure is as follows:

1. Make a plot of pressure versus cumulative production for the first few years from the discovery date, assum-

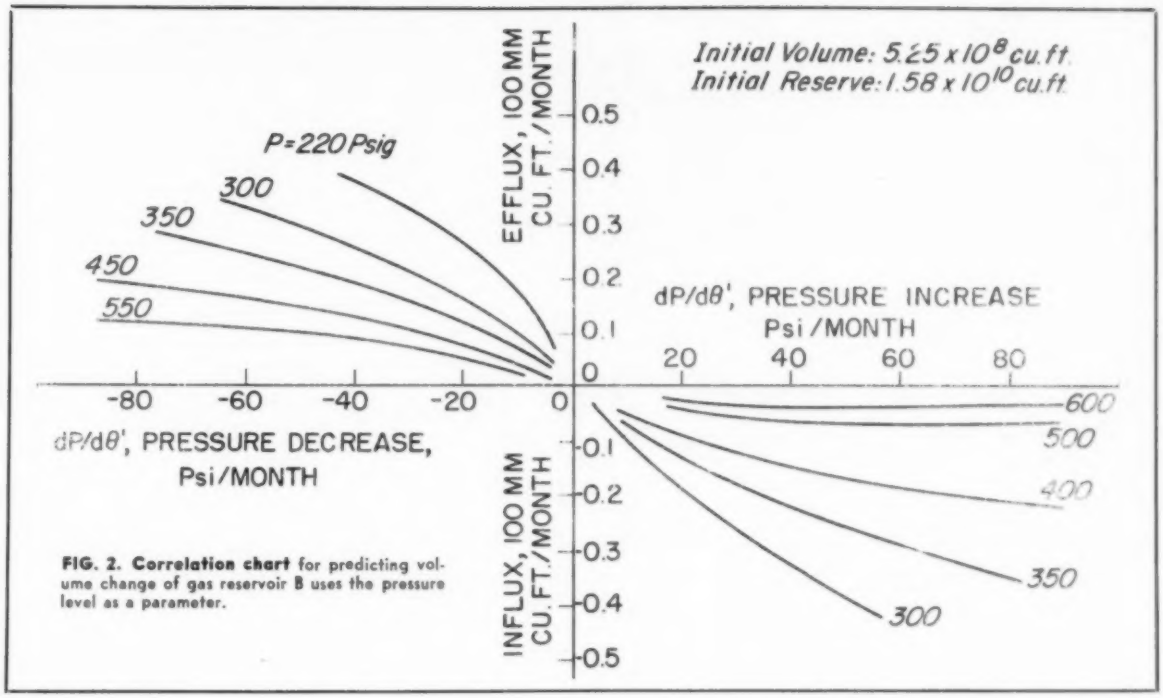


FIG. 2. Correlation chart for predicting volume change of gas reservoir B uses the pressure level as a parameter.

ing a constant volume model for short periods and estimate the initial reservoir volume. Inaccuracy of the initial volume estimation does not influence the correlation seriously.

2. Make a table of the following variables:
   Time (Θ') z P $dp/d\Theta'$ n V $dV/d\Theta'$
3. Make a plot of $dV/d\Theta'$ versus $dP/d\Theta'$ with a parameter of pressure level to prepare Fig. 2, or similarly, for Fig. 3. It should be pointed out that these charts are good only for the particular field being studied, and their predictive accuracy should increase with the amount of production-pressure data upon which they are based.

Example Solution by Empirical Correlation Method

The example is worked out for the gas reservoir B in Michigan discovered in 1944. Following the procedure given above, Fig. 2 and 3 are prepared. While a technique of successive approximations must be used to determine varying reservoir size, the first approximation may be based upon the ideal gas law as applied to the constant volume reservoir.

Data:

$n_{Jan} = 1.46 \times 10^{10}$ cu ft (1 atm, 60 F)
$n_{Dec} = 1.70 \times 10^{10}$ cu ft (1 atm, 60 F)
$P_{Dec} = 424$ psig
$V_{Dec} = 5.64 \times 10^8$ cu ft
$V_{Jan} = znRT/P = (15.58)\ (1.46 \times 10^{10})z/P$

For the first approximation:

$$P_{Jan\ (approx)} = \frac{(RT)\ (n_{Jan})\ (z)}{V_{Dec}} = \frac{(15.58)\ (1.46 \times 10^{10})\ (0.94)}{5.64 \times 10^8}$$
$$= 379 \text{ psia}$$

Therefore,

$$dp/d\Theta' \cong 379 - (424 + 14.7)$$
$$\cong 60 \text{ psi per month decrease}$$

From Fig. 2, with the approximated pressure and the rate of pressure change, rate of volume change is read to be 0.21×10^8 cu ft.

Then,

$$V = (0.21 + 5.64) \times 10^8 \text{ cu ft}$$

and,

$$P_{Jan} = \frac{(15.58)\ (1.46 \times 10^{10})\ (0.945)}{5.85 \times 10^8} =$$
$$= 368 \text{ psia or } 353 \text{ psig}$$

For the purpose of comparison, some calculated results are given in Table 3.

Summary

The problem of predicting the volume variations of a gas storage reservoir resulting from water encroachment due to pressure variations has been studied by theoretical and empirical means. The graphical method is based upon theoretical considerations and application of a material balance equation. It is in general applicable to all storage reservoirs with water drive.

TABLE 3. Comparison of Predicted Pressure with Observed Values for Reservoir B.

Date	Actual Pressure — psig	Predicted Pressure (Constant initial volume 5.25×10^8) — psig	(% error)	Predicted Pressure from Fig. 2 — psig	(% error)	Predicted Pressure from Fig. 3 — psig	(% error)
Jan 1957	354	395	(11.6)	353	(−0.28)	352	(0.57)
Feb 1957	291	339	(16.5)	289	(−0.69)	287	(−1.37)
Mar 1957	346	394	(13.9)	356	(2.90)	349	(0.87)
Apr 1957	358	397	(10.9)	360	(0.57)	353	(−1.40)
Jun 1957	417	452	(8.4)	423	(1.44)	413	(−0.96)

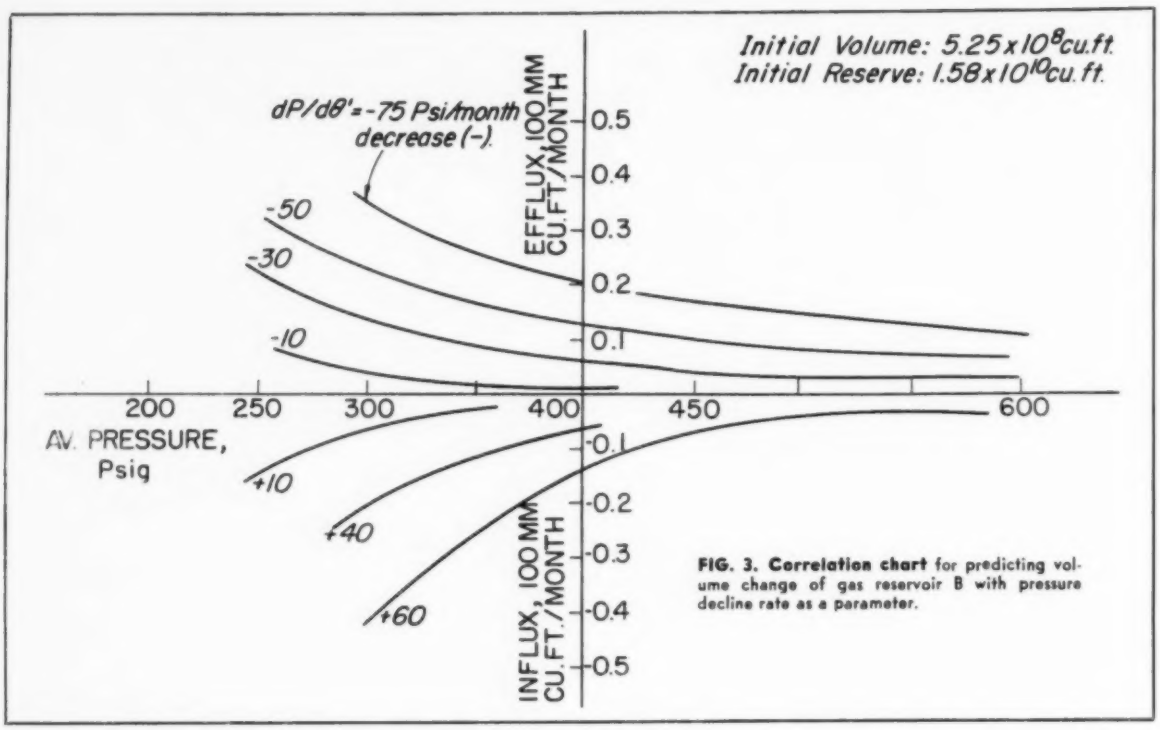


FIG. 3. Correlation chart for predicting volume change of gas reservoir B with pressure decline rate as a parameter.

The correlation method permits the prediction of future behavior of the storage reservoir purely from the past behavior of that particular reservoir. Consequently it is purely empirical and applies only to the particular reservoir for which it is developed.

Acknowledgment

The authors wish to acknowledge the financial assistance and support provided by the Michigan Gas Association through their fellowship program at the University of Michigan. Field data used during the calculations were contributed by the Michigan Consolidated Gas Company.

References

1. Bruce, W. A., "Pressure Prediction for Oil Reservoirs," *Trans.* AIME, 1943.
2. Carslaw, H. S. & Jaeger, J. C., "Conduction of Heat in Solids," Oxford at the Clarendon Press, 1959.
3. Crank, J., "The Mathematics of Diffusion," Oxford at the Clarendon Press, 1956.
4. Katz, D. L. & Cornell, D., "Flow of Natural Gas from Reservoirs," University of Michigan, Ann Arbor, 1955.
5. Katz, D. L., Tek, M. R., and Coats, K. H., "The Effect of Unsteady-State Aquifer Motion on the Size of an Adjacent Gas Storage Reservoir," *Trans.* AIME, 216, 18, 1959.
6. Muskat, M., *Physical Principles of Oil Production*, McGraw-Hill Book Company, 1949.
7. Van Everdingen, A. F. & Hurst, W., "The Application of the Laplace Transformation to Flow Problems in Reservoirs," *Trans.* AIME, 186, 305. 1949.

Nomenclature

P = Pressure, psi
r = Radius of aquifer, cm
r' = Radius of aquifer, ft
c = Liquid compressibility with formation factor, (vol)/(vol)(atm)
c' = Liquid compressibility factor, (vol)/(vol)(psi)
ϕ = Porosity, dimensionless
μ = Viscosity of brine, centipoise
k = Permeability of brine through sand, darcy
Θ = Actual time, second
Θ' = Actual time, month
r_g = Radius of gas field, cm
$r_D = r/r_g$, dimensionless
$t_D = k\Theta/\phi\mu c\, r_g^2$, dimensionless
τ = A new time function, dimensionless
$L\{Q_{t_D}\}$ = Laplace transform of cumulative influx or efflux function
K_1 = Second kind of bessel function of first order (modified)
K_0 = Second kind of bessel function of zero order (modified)
Q'_{t_D} = Cumulative influx or efflux function for constant pressure case or integrated pressure gradient over dimensionless time t for constant pressure case, dimensionless
Q_{t_D} = Cumulative influx or efflux function for arbitrary pressure variation case, psi
$G(t_D - \tau)$ = Function G at time $(t_D - \tau)$
ω = Period, dimensionless
W = Cumulative influx or efflux at any time, cu ft
ΔN = Cumulative oil production, bbl
B = Formation volume factor, dimensionless
v = Reservoir volume per std cu ft of gas, cu ft
R' = Gas-oil ratio, cu ft/bbl
s = Laplace transform variable
S = Solubility, cu ft/bbl
N = Initial oil reserve, bbl stock tank oil
S_o = Initial solubility, cu ft/bbl
B_o = Initial formation volume factor, dimensionless
h = Brine sand thickness, ft
V = Net gas storage volume (void), cu ft
n = Reserve or stored gas, std cu ft
z = Compressibility of gas, dimensionless
R = Gas constant
$Q'_{t_D}(t_D - \tau)$ = Q'_{t_D} function at $(t_D - \tau)$, dimensionless

APPENDIX

A. Radial Diffusivity Equation With Arbitrary Pressure Variation

One can show that the boundary conditions to the dif-

ferential Equation 2 give the Laplace transform of the cumulative influx function to be as follows:

$$L\{Q_{t_D}\} = \frac{1}{s}\, g(s)\, \frac{\sqrt{s}\, K_1(\sqrt{s})}{K_0(\sqrt{s})}$$

$$= \{sg(s)\} \left\{ \frac{K_1(\sqrt{s})}{s^{3/2} K_0(\sqrt{s})} \right\} = f_2(s) \cdot f_1(s)$$

where

$$f_1(s) = \frac{1}{s^{3/2}} \cdot \frac{K_1(\sqrt{s})}{K_0(\sqrt{s})}$$

(or $\overline{Q}_p$ in Equation VI - 27, p. 314, Reference 7.)

and

$$f_2(s) = s \cdot g(s)$$

Then,

$$F_1(t_D) = Q'_{t_D} = L^{-1}[f_1(s)]$$

and

$$F_2(t_D) = \frac{dG(t_D)}{dt_D} = L^{-1}[f_2(s)]$$

(Q'_{t_D} is the value given in Table I, p. 314, Ref. 7.)

Therefore, the inversion becomes:

$$Q_{t_D} = \int_0^{t_D} \left(\frac{\delta P}{\delta r_D} \right)_{r_s} dt_D = \int_0^{t_D} \left[\frac{dG(t_D - \tau)}{d\tau} \right] \cdot Q'_{t_D}(\tau)\, d\tau$$

$$= \int_0^{t_D} \frac{dG}{d\tau} \cdot Q'_{t_D}(t_D - \tau)\, d\tau, \quad . \quad . \quad . \quad (6)$$

Equation 6 is a solution to the differential Equation 2 with any sectionally continuous pressure function of which the Laplace transform exists.

B. Integration of Eq. 6 By Graphical Method

In order to calculate the varying pressure-cumulative production function Q_{t_D} from the pressure-time variation and the dimensionless constant pressure-cumulative production function of Q'_{t_D}, a plot of $G(\tau)$ versus $Q'_{t_D}(t - \tau)$ is made. The integration of Q' curve along the ordinate is represented by the areas indicated on Fig. 4. It may be noted that the area (A) below $G = P_o$, the discovery pressure line, corresponds to water influx, while the area (B) above the discovery pressure line represents the efflux of water from the reservoir. Fig. 4 represents the graphical integration for a given dimensionless time (t_D). The procedure repeated at each considered value of dimensionless time and the total net area Q_{t_D} resulting from each graphical integration is obtained as a function of time. Knowing Q_{t_D} at any time, the actual cumulative water influx is calculated from Equation 10.

A typical sequence of varying pressure-cumulative influx calculations is included below for December, 1964 ($\Theta' = 288$ months).

The first step is to relate the actual time and the dimensionless time with the selected reservoir properties. The following data are selected:

$k = 0.18$ darcy
$\Theta = (288)(30)(24)(3600)$ seconds
$\phi = 0.2$
$\mu = 0.4$ cp
$c = 4.4 \times 10^{-5}$ (vol)/(vol)(atm)
$r_g = 2.46 \times 10^5$ cm

$$t_D = k\Theta/\phi\mu c r_g^2$$
$$= \frac{(0.18)\,[(288)(30)(24)(3600)]}{(0.2)(0.4)(4.4 \times 10^{-5})(2.46 \times 10^5)^2}$$
$$= (2.18)(288) = 628$$

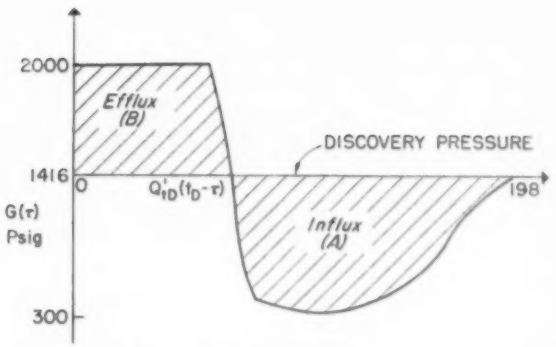


FIG. 4. Example graphical integration for the cumulative influx function with arbitrary pressure variation.

The next step is to make the following tabulation with the given pressure variation:

Θ' — months	$G(\tau)$ — psig	τ	$(t_D - \tau)$	$Q'_{t_D}(t-\tau)$*
0	1416	0	628	198
12	1320	26.2	602	190
48	610	104.5	523	168
96	365	209	419	140
144	370	314	314	109
168	420	366	262	94.5
180	460	392	236	87
192	500	418	210	79
204	525	445	183	70
207	535	451	177	67.5
214	1700	467	161	63
219	1700	477	151	60
220	2000	480	148	59
288	2000	628	0	0

*Taken from Reference 7.

A plot of $G(\tau)$ versus $Q'_{t_D}(t - \tau)$ is made as sketched on Fig. 4 to obtain Q_{t_D}.

The total net area (sum of A and B) is 99,660 psi from the graphical integration on Fig. 4.

Using Equation 10:

$$W = 2\pi\phi c' r'^2_g h Q_{t_D} = 2\pi(0.2)\,(3 \times 10^{-6})\,(8.06 \times 10^3)^2(7)Q_{t_D} = (1.72 \times 10^3)Q_{t_D} = (1.72 \times 10^3)\,(99{,}660) = 171.5 \times 10^6 \text{ cu ft}$$

where

$\phi = 0.2$
$c' = 3 \times 10^{-6}$ (vol)/(vol) (psi)
$r'_g = 8.06 \times 10^3$ ft
$h = 7$ ft

C. Sample Calculation of Cumulative Influx by Material Balance

The cumulative influx calculation using Equation 9 is shown for 1954.

$\Delta N = 37.3 \times 10^6$ bbl stock tank oil (cumulative production)
$B = 1.194$ reservoir bbl/stock tank bbl
$R' = 871$ cu ft/bbl
$S = 335$ cu ft/bbl
$v = 0.0354$ cu ft/cu ft
$N = 66.4 \times 10^6$ bbl stock tank oil
$B_o = 1.332$ reservoir bbl/stock tank bbl
$S_o = 685.4$ cu ft/bbl

$$W = \Delta N[5.61B + v(R' - S)] - N[5.61B + (S_o - S)v - 5.61B_o] = 37.3 \times 10^6[(5.61)\,(1.194) + (0.0354)(871 - 335)] - 66.4 \times 10^6[(5.61)\,(1.194) + (685.4 - 335)\,(0.0354) - (5.61)\,(1.332)] = 187 \times 10^6 \text{ cu ft}$$

* * *

P 214.01
537.9

Two-liquid system resulting from . . .

Addition of LPG and Gas to an Oil

Laboratory studies of the mixture of LPG and gas with oil under various conditions can help anticipate difficulties which might arise in some of the new secondary-recovery processes

J. G. Roof and N. W. Crawford, Jr.
Shell Development Company
Houston, Texas

INJECTION OF LPG AND GAS into an oil reservoir can, under certain circumstances, lead to rather complicated phase conditions in the reservoir. As a part of an engineering study for a possible secondary-recovery project in an Oklahoma field, a laboratory examination has been made of the volumetric and phase behavior of oil from that field when propane and methane were added. Proper analysis of the resulting data will permit determination of the most efficient injection program.

Procedure and Materials

Production from the well under study was through a separator operating at 106 F and 400 psig. The observed separator gas-separator liquid ratio was 2760 cu ft per bbl. The tank oil had a gravity of 47.9 deg API and was of relatively dark color. The gas-oil ratio at this time was considerably higher than at the time of discovery. Pressure measurements during and after sampling gave 1190 and 1555 psig as the flowing and static bottom-hole pressures, respectively.

When separator gas and separator oil were recombined in a windowed cell[1] in the produced ratio, the resultant system demonstrated condensate behavior at reservoir temperature. Since this is known to be an oil reservoir, it is apparent that the gas-oil ratio of 2760 cu ft per bbl is not representative of the composition in place.

Since the gas phase in the reservoir is estimated to occupy about 20 percent of the total hydrocarbon volume, the recombined reservoir fluids were modified to give a system having 80 percent relative liquid volume at 1555 psig and 171 F. The recombined sample was flash-expanded to 1190 psig and equilibrated. A part of the excess "bottom-hole flowing gas" was displaced from the cell at constant pressure. The remaining fluids in the cell were repressured to 1555 psig and re-equilibrated. If the liquid relative volume was still less than 80 percent, the sample was again expanded to 1190 psig, shaken, and bled down a bit more. After the proper liquid relative volume of 80 percent at 1555 psig was achieved by this method, the gas was displaced at that pressure to leave in the cell a sample of "reservoir liquid" for the experiments.

The methane and propane added to the oil were commercial products of approximately 99-percent purity.

Test Results

The reservoir liquid, prepared as above, was completely miscible with propane at reservoir temperature (171 F) and pressure (1555 psig). Upon addition of methane to the reservoir

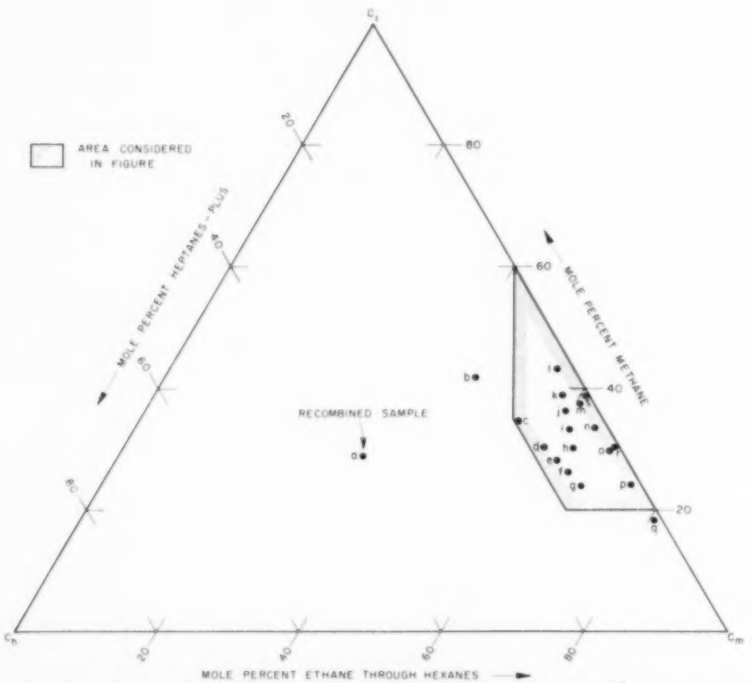


FIG. 1. **Compositional diagram** shows the composition of the reservoir liquid (point *a*) and that of 18 mixtures (*b* through *s*) of this liquid with propane and methane.

liquid, the bubble-point pressure rose to a critical point in excess of 6000 psi, as is typical of such systems. However, when an attempt was made to determine the bubble-point locus across a mock-ternary* diagram by successive additions of propane and methane, it was found that near the critical point two liquid phases could coexist either by themselves or with a gas phase.

Fig. 1 is a mock-ternary diagram showing the composition of the reservoir liquid (point *a*) and that of eighteen mixtures (*b* through *s*) of this liquid with propane and methane. At each of these nineteen points an isothermal flash expansion was made in order to observe the volumetric and phase behavior under equilibrium conditions. As examples of the type of behavior found, plots of relative volumes of the three phases at points *j*, *k*, and *m* of Fig. 1 are shown in Fig. 2. The symbol L_I is used to indicate the lighter colored, less dense liquid and L_{II} the more dense and darkly colored, almost opaque liquid. It will be noted that the relative amount of L_{II} is never especially great in this case (up to 13 percent of the total volume) and that its maximum occurs at or near a saturation pressure. At *j* the maximum of L_{II} occurs near the bubble point as the gas phase disappears with increasing pressure; whereas at *k* and *m* the maximum of L_{II} occurs near the pressure at which L_I vaporizes completely. At 1600 psig, for example, when the composition is that at *j*, L_{II} coexists with L_I; whereas, at the same pressure at *k* and *m*, L_{II} coexists with the gas phase.

The results of the observations at sixteen compositions are shown in Fig 3, which covers only that portion of Fig. 1 enclosed by the hatched lines. Only a few compositions were found to yield L_{II} with L_I or G or both.

In Fig. 3 an attempt has been made to indicate areas in which the various phases and combinations of phases appear. Two coexistent liquids were not found at pressures above 1800 psi nor below 800 psi. Within that range of pressure, the composition range within which $L_I + L_{II}$, $L_I + L_{II} + G$, or $L_{II} + G$ appeared depended on the pressure. In Fig. 3 these areas are *suggested* at four pressures. The positions and shapes of the lines of demarcation between adjacent areas are not known.

Representation of the over-all composition of the system by a point in Fig. 3 is possible. However, tie lines between coexistent phases would be essentially meaningless since two corners of the triangle represent mixtures. For instance, not only do coexistent L_I and L_{II} differ in content of C_h, but also the composition of C_h is different in the two liquids, as shown in a following paragraph. The dashed lines in Fig. 3, therefore, only *suggest* the areas within which certain combinations of phases were found and cannot be interpreted as in a true ternary diagram.

With increase of pressure from 800 psi, the three-phase state ($L_I + L_{II} + G$) first appears near the $C_1 - C_m$ boundary; as the pressure rises, the area in which three phases can coexist moves, in general, away from the $C_1 - C_m$ boundary and appears to cover a smaller range of the ratio $C_1 : C_m$.

In one experiment, when the composition of the system was approximately that shown by point *k* in Fig. 1, an attempt was made to remove portions of each of the three coexistent phases for analysis by low-temperature fractional distillation. A portion of the gas phase was displaced from the cell and was analyzed (analysis A in Table 1). Since equilibrium in this region was very pressure sensitive, it is likely that analyses B and C are contaminated portions of liquids L_I and L_{II}, respectively.

It is evident that the three phases differ considerably in C_1 and C_h content and that there is considerable fractionation of the C_h, with the heaviest molecules being preferentially concentrated in L_{II}.

*It is often convenient to represent a natural hydrocarbon system on a triangular composition plot having methane, ethane-through-hexanes, and heptanes-plus as the three components[2]. Since such representation is not basically sound, there is a need for qualifying such diagrams as being potentially misleading. The term *pseudo-ternary* has already been used in another sense by writers on phase behavior; the term *mock-ternary* is proposed for these representations of composition.

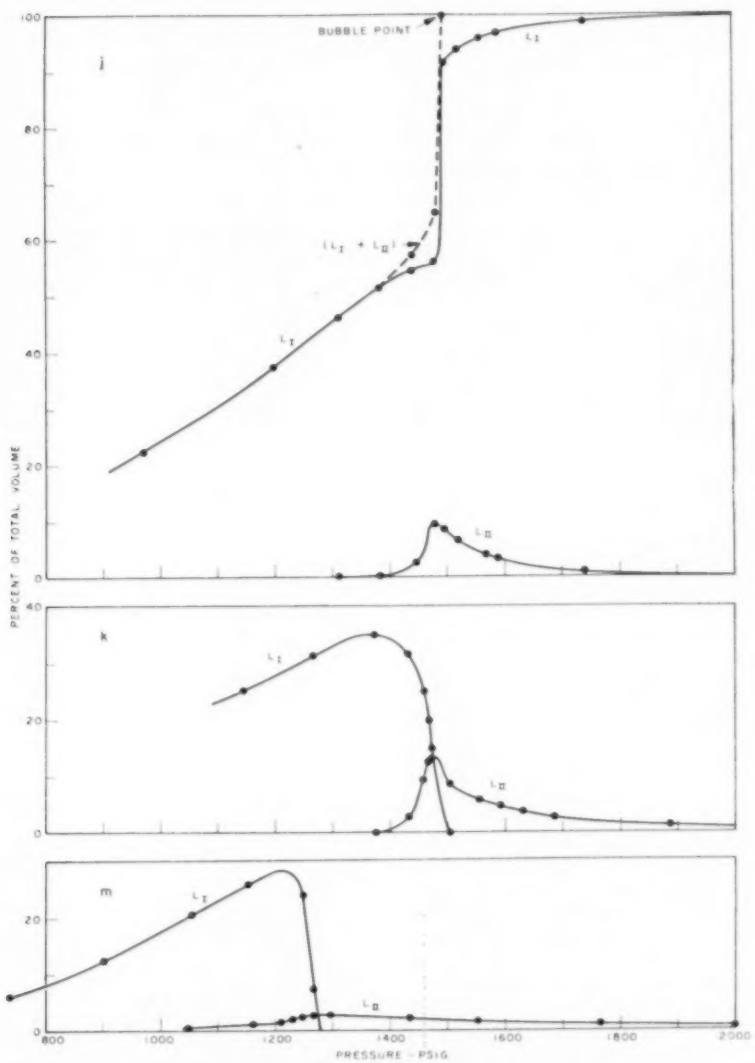


FIG. 2. **Relative volumes of liquid phases** are illustrated for three points (*j*, *k*, and *m*) from the diagram in Fig. 1.

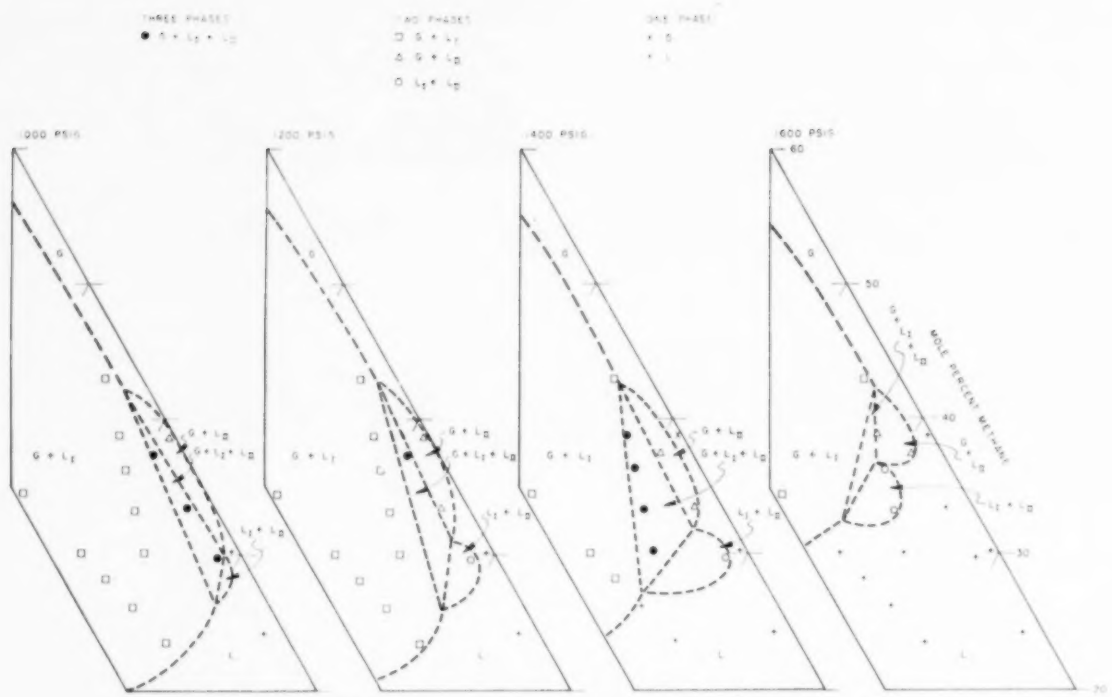


FIG. 3. **Phase behavior** in the critical region outlined by hatched lines in Fig. 1.

Table 1. Analysis Near Composition *k*

(Compositions in mole percent)

	A	B	C
C_1	39.4	34.0	29.2
C_m	57.2	58.8	62.8
C_h	3.4	7.2	8.0
Mol. wt. of C_h	145	165	205

After mixtures of C_1 and propane (the latter as representative of the C_m fraction) were found to cause the formation of two liquid phases in this reservoir liquid, a few experiments were run on mixtures of C_1 and pentane with the reservoir liquid. The simultaneous presence of two liquid phases was found again only near the critical region and at a saturation pressure. The phenomenon seemed to be less pronounced, however, when pentane was used instead of propane, since only a trace of L_{II} was observed and that at only one composition.

Discussion

Our experiments have shown the behavior of one reservoir liquid upon addition of LPG and gas. Just how widely this type of behavior occurs has not been determined. Eilerts *et al*[3] observed the presence of two liquids in equilibrium over a narrow range of temperatures and pressures close to the critical state (−63 F and 1156 psia) of a condensate sample prepared by recombination of separator fluids in the produced ratio. The liquids were separated by a well-defined meniscus and were of two different shades of amber. The two liquids did not appear at temperatures above the critical nor at three other recombination ratios.

Katz and co-workers [4] obtained four phases when a 24.4 deg API crude was treated with propane and a natural gas at elevated pressures. The fourth phase was a plastic solid. In addition, with that crude, deasphaltizing was found to take place when propane alone was added to the crude.

Considerable literature exists on the precipitation of solids or semisolids upon addition of LPG constituents to natural oil systems. A review of this problem was presented recently.[5] It includes a brief discussion of conditions leading to formation of two liquid phases when propane is added to a Mid-Continent distillate. Our sample is of interest in that addition of propane alone caused no formation of a second liquid phase; only when both propane and methane were added to the oil did the second darker, denser, and apparently more viscous liquid phase form. This denser liquid flowed readily in the cell and was rapidly redissolved upon changes in pressure or composition. At one time, a sample was left standing in the cell at reservoir temperature for a period of two weeks in the $L_I + L_{II}$ state. Afterward, a moderate pressure increase with agitation caused L_{II} to redissolve rapidly.

In contrast to this behavior, another oil, when mixed with propane at reservoir temperature and pressure, precipitated a black material which was solid or semisolid and which would redissolve very slowly, if at all, upon changes in pressure and composition. This would appear to be the more common type of behavior of a dark oil mixed with LPG and gas. In such cases, possible difficulties might be anticipated during application of some of the newer secondary-recovery processes. On the other hand, addition of propane — or in our sample, propane plus methane — may result in a system having two liquid phases. The second liquid phase (the darker and denser of the two) is reversibly soluble upon changes in pressure or composition and presumably would be less likely to lead to serious difficulties in such LPG-gas drives.

References

1. Wells, F. W., and Roof, J. G.: "Pressure Vessel with Internal Window," *Rev. Sci. Instruments*, 26, 403 (1955).

2. Slobod, R. L., and Koch, H. A., Jr.: "High-Pressure Gas Injection—Mechanism of Recovery Increase," ***Drilling & Production Practice API***, (1953) pp. 82-96.

3. Eilerts, C. K., Barr, V. L., Mullens, N. B., and Hanna, B.: "Phase Relations of a Gas-Condensate Fluid at Low Temperatures, Including the Critical," *Petroleum Engineer*, 19, (No. 5), 154-180, February 1948.

4. Vink, D. J., Ames, A. M., David, R. A., and Katz, D. L.: "Multiple-Phase Hydrocarbon Systems," *Oil and Gas Journal*, 34, 37, 38, November 21, 1940.

5. Bossler, R. B., and Crawford, P. B.: "Asphalt, Wax, and Heavy Oil Deposition during Miscible Displacement of Crude Oil by Propane," *Proceedings of the Eleventh Oil Recovery Conference, Bulletin* 67, 210-27, Texas Petroleum Research Committee, Austin, May 9, 1958.

★ ★ ★

P 420.112.93

VELOCITY LOGGING: A New Family

Principle of measuring sound waves traveling through the earth's formations, long applied in seismology, is "borrowed" for new applications in oil well logging . . . permitting one log to benefit engineer, geologist and geophysicist

Howard Itten, *Logging Division, Empire Geophysical, Inc., Fort Worth, Texas*

THE METHOD OF SENDING out a sound wave and measuring its time of arrival at a sound receiving source has opened a new field of oil well logging that is rapidly gaining in popularity and acceptance by the oil industry.

Historically, logging techniques have made use of the physical properties of the earth's formations to measure, identify and interpret changing conditions in the materials through which drilling operations are conducted. The sending out of a sound wave makes use of a principle long known and utilized in seismic theory and the application of seismic theory to petroleum exploration techniques. This is, however, a physical field to which logging methods have only recently been applied for other than geophysical objectives.

With the advent of electric logging in the early days of the logging industry's history, we dealt only with certain physical properties of current flow in the formations adjacent to the borehole. The field of electrical logging has been progressive and today electric logs furnish the basis for most open hole types of logging.

As greater knowledge was needed, another physical property was exploited to produce the well known family of radioactive logs serving the industry today. This development made it possible to log not only in open holes, but to provide certain information behind casing in cased wells.

Sound transmission — or acoustic properties of the earth's formations — are now providing still another family of logs which are being utilized by engineers, geologists and geophysicists. At this time the acoustic principle, or velocity logging as it is frequently referred to, is primarily an open hole method and as such competes with electric logs in many respects.

One Log for All

The logging industry is now being called upon to provide, in one integrated service, information for all segments of the oil industry. The geophysicist wants and must have as much velocity information available to him as may be economically gathered. The geologist, the reservoir engineer and the development engineer need lithology, correlation, porosity and fluid saturation data in order to drill, complete and estimate reserves in the course of their activities.

Originally developed for geophysical velocity determination, the tool was first known and introduced to the industry as the continuous velocity logging system by virtue of the fact that it measured time over a specified distance and could be run without stopping in the hole. The acoustic or velocity method has, since its first introduction, become increasingly important through recognition that by timing sound transmission through a material a measurable physical characteristic is produced which can be interpreted to fit changing formation conditions.

As a practical matter, it has been found that porosity is accurately and reliably determined from velocity logs regardless of saline or chemical fluids, a condition which has troubled the logging industry for many years and thereby provides a distinct advantage that velocity logging has over electrical methods. Fig. 1 demonstrates porosity as determined from the velocity log compared to porosities obtained from core analyses.

Single Receiver Tool

Correlation has proven to be exceptionally good with velocity logs. The original version, as a single receiver velocity log, has provided the basic and best stratigraphic correlation tool. Fig. 2 shows an example of single receiver correlations.

Therefore, at least in the VS-Acoustic system with which the author is most familiar, the single receiver has been retained as a valuable and important part of the system, even though the more modern version, a two-receiver system, has distinct advantages in the accuracy of measurements made.

The system provides both the basic single curve and the two-receiver curve simultaneously, and in addition to the advantage of preserving the good correlation qualities of the single curve, a number of additional advantageous features result from this combination.

The single receiver, run simultaneously with the dual receiver curve, serves as a monitor, preventing misinterpretation of poor or "no signal" conditions. Fig. 3 is an example of this very important interpretive advantage. On the right of the figure are representations of the first and second receiver signals shown in the circles marked A and B, as observed in a visual surface monitoring system. In Case A a normal signal is being received at both the first and second receivers. In Case B a weak signal is obtained at the second receiver and you will note that arrows designating the timing picks on the two receivers have moved back into a second leg of the signal event on the second receiver.

The effect on the dual receiver log is shown by the extreme break of the logging trace to the left (the cross-

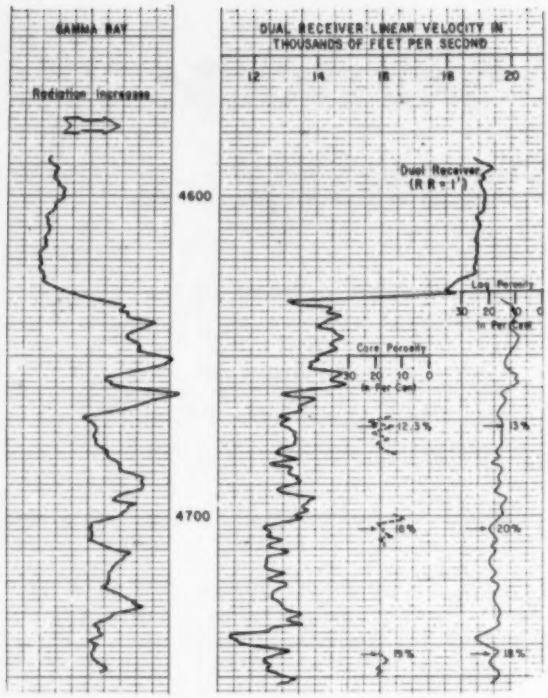
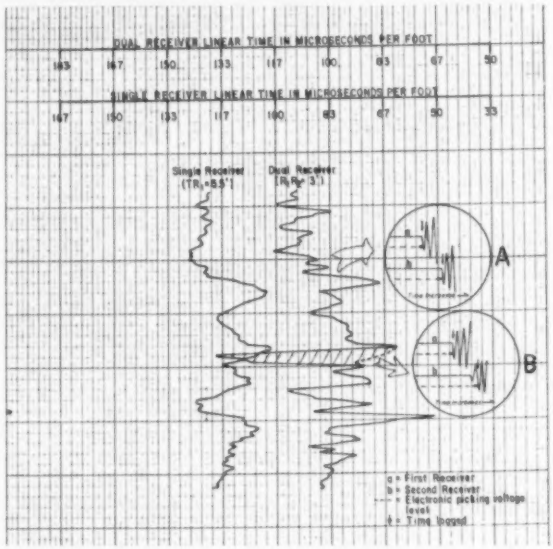


FIG. 1. **Porosity** as determined from velocity log, compared to porosity obtained from core analyses.

FIG. 3. **Surface monitoring** presentation of the acoustic system is illustrated in A and B. The single run simultaneously with the dual receiver curve serves as a monitor preventing misinterpretation of the weak second receiver signal shown in B. The single curve permits the logging engineer to mark log correctly as shown by dashed line.



hatched area). It is noted that no corresponding decrease in velocity at this point occurs on the single receiver and, therefore, we interpret poor or late signal reception at the second receiver. The dual receiver may then be corrected through this poor signal zone as indicated by the dotted in portion of the curve on the dual receiver. This interpretation could not be made without the single receiver as a monitor.

Dual Receiver

Characteristics of the single and the dual differ in washed out zones, and in this connection the single receiver curve is important in properly interpreting the signal events of the dual receiver curve as well as interpretation of the boundaries of the washed out zones. Fig. 4 demonstrates this feature.

It should be noted that certain false excursions are recorded at the boundaries. A sample portion of a log containing numerous washed out zones is shown, and cross-hatched are typical examples. Other examples may also be seen by studying Fig. 4. Such excursions should be taken into account in interpreting the velocity log.

Since we are dealing with a sound system and are transmitting sound waves which must be received and amplified, it is likely that there will be random noise conditions that occasionally will affect and interfere with the desired signal as it is received. When such takes place, regardless of its source, noise spikes or spurious signal generation takes place. The single and

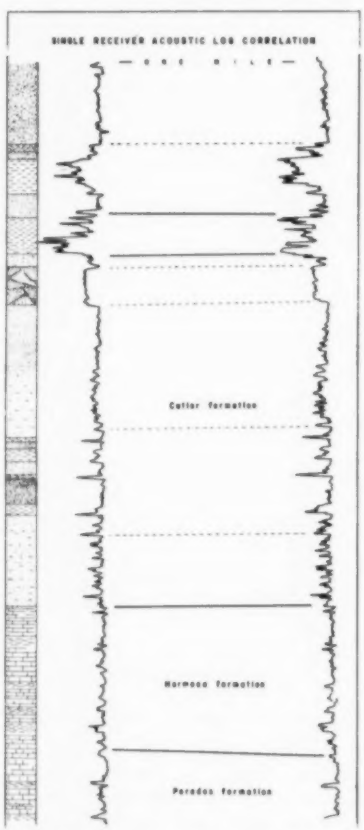


FIG. 2. **Correlation** has proved to be exceptionally good with velocity logs. The original version, a single receiver acoustic log shown here, has provided the best basic stratigraphic correlation tool.

the dual as a simultaneous feature enables the user of the log to interpret such spurious or inaccurate information and eliminate it from his studies and the information which he might otherwise erroneously use.

An extreme example of this condition is shown in Fig 5. Here the condition is imposed upon uniform velocity conditions and consequently provides a strong standout for the purpose of this example. In a more active log with less uniform velocities through a particular zone, this condition will be less obvious but may be interpreted by studying the log.

Borehole Changes

Ordinary borehole size changes can be detected by comparing the single and the dual together. Fig. 6A and 6B show this situation, which may be of considerable value although not the primary objective for running this type log. Fig. 6A demonstrates the additional mud travel time being measured by the single receiver curve represented by the cross-hatched area. In this figure three different hole sizes in sand and shale sections may be detected. Fig. 6B is interesting primarily because bore size changes are demonstrated going from a soft formation, shale, to a hard formation, Mississippian limestone.

An examination of this figure reveals that the dual receiver curve in the limestone reflects a very uniform velocity, while the single receiver curve tends to drift toward lower velocity

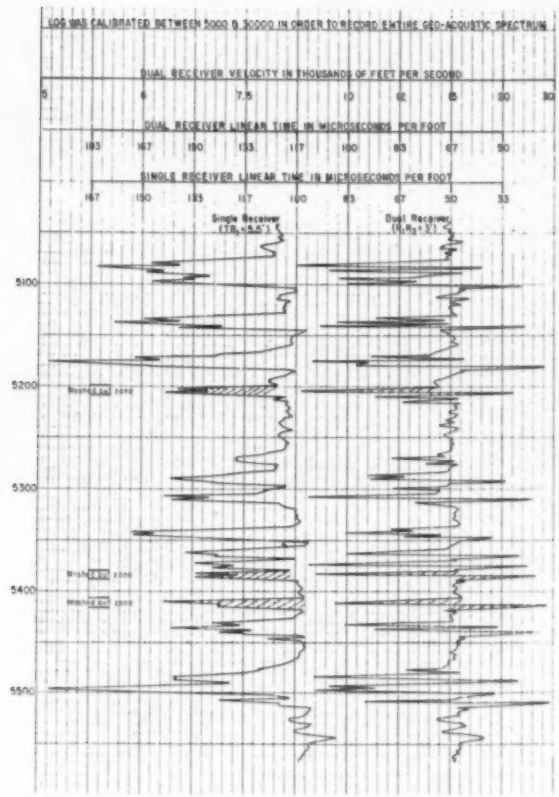

LOG WAS CALIBRATED BETWEEN 5000 & 30000 IN ORDER TO RECORD ENTIRE GEO-ACOUSTIC SPECTRUM
DUAL RECEIVER VELOCITY IN THOUSANDS OF FEET PER SECOND
DUAL RECEIVER LINEAR TIME IN MICROSECONDS PER FOOT
SINGLE RECEIVER LINEAR TIME IN MICROSECONDS PER FOOT
Single Receiver
Dual Receiver
5100
5200
5300
5400
5500

FIG. 4. **Single receiver curve** enables proper interpretation of signal events of the dual receiver curve as well as interpretation of the boundaries of the washed out zones. Stratigraphic correlation of single receiver curve is superior to dual curve.

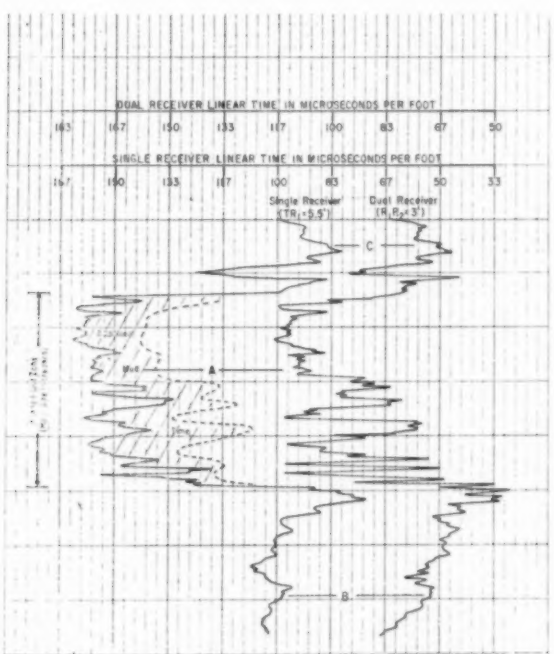


FIG. 6-A. **Borehole size changes** can be detected by comparing the single and dual together. Here, A, B, and C indicate three different hole sizes in sand and shale section.

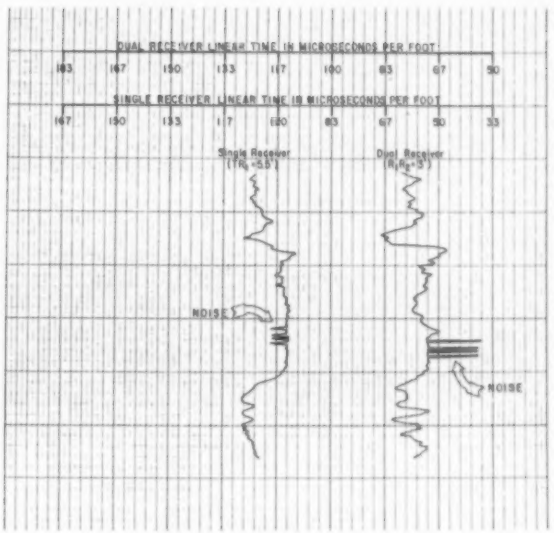
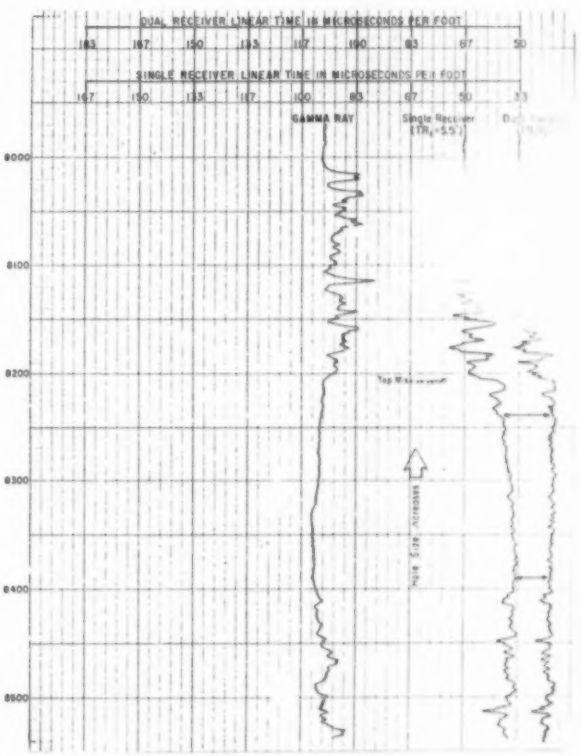


FIG. 5. **Single and dual** as a simultaneous feature enables the user of the log to interpret random noise. Strong standout of noise signal is due to uniform velocity conditions.



F.G. 6-B. **Single receiver time** increases indicating a longer mud path time which means a larger hole.

"Well-Qualified"
BAKER
production packers

BAKER DRILLABLE PRODUCTION PACKERS

SINGLE ZONE OR MULTIPLE-ZONE

BAKER MODEL "D" RETAINER PRODUCTION PACKER

PRODUCT NO. 415-D

The most widely used drillable packer in the world. Contains continuous sealing bore and flapper-type back-pressure Valve.

BAKER MODEL "DA" RETAINER PRODUCTION PACKER

PRODUCT NO. 415-DA

Direct variation of Model "D" with a larger I.D. sealing bore located in the upper end of the packer. Permits larger bore through the packer accessories. Used as an upper packer in two-packer flowing or pumping, parallel string hook-ups.

BAKER MODEL "F" RETAINER PRODUCTION PACKER

PRODUCT NO. 415-F

Related design to Model "D." Contains larger continuous bore than Model "D." Used where extra large bore is required in some parallel (triple) string, flowing or pumping hook-ups.

BAKER MODEL "FA" RETAINER PRODUCTION PACKER

PRODUCT NO. 415-FA

Related to the Model "F" Packer in the same manner that the Model "DA" is to Model "D." Contains extra large upper sealing bore. Provides largest I.D. of any retainer-type packer. Used primarily in multiple string hook-ups.

BAKER MODEL "H" RETAINER PRODUCTION PACKER

PRODUCT NO. 416-H

Similar to other Baker Retainer Production Packers, but employs differently designed components. Is set on tubing ready for production in one-half a round trip. Same bore size as Model "D"; and can use same accessories once the setting seal mandrel is removed.

Out of this *complete* line of new and modern packers you can fulfill any production need from simple single-zone installations through the increasingly popular and profitable multiple-completions to efficient water-flood applications.

Regardless of depth, pressure differentials, temperatures or other well conditions, one (or a combination) of these Baker Packers is exactly "tailored" to your well requirements. Baker offers the complete line, both retrievable and drillable types—with a choice of setting methods—to satisfy any surface or sub-surface condition.

Turn to Page 492 of your new BAKER (or Composite) Catalog for the 46-page section containing complete descriptions, applications and specifications on all Baker Packers.

BAKER RETRIEVABLE PRODUCTION PACKERS

MULTIPLE-ZONE | *SINGLE ZONE AND WATER FLOODING*

BAKER MODEL "G" PARALLEL PACKERS

Single-Grip PRODUCT NO. 740-G
Double-Grip PRODUCT NO. 741-G

The ideal retrievable upper packer for two-packer, parallel string dual-zone installations. Embodies full-opening, long string through lower packer with separately retrievable short string that can be anchored to upper packer if desired. Double-Grip version is identical to Single-Grip, but in addition contains hydraulically actuated, button-type hold-down.

BAKER MODELS "MOA" AND "MOB" CROSS-OVER SNAP-SET PACKERS

PRODUCT NOS. 636-MOA AND 636-MOB

Used as the upper retrievable packer in single-string two-packer, selective cross-over tubing and annulus dual-zone production hook-ups. Set with set-down weight. Released and recocked for repeat setting by picking up on tubing. Also available with hydraulically actuated button-type hold-down.

BAKER DUAL PUMPING PACKER

PRODUCT NO. 694

Used as the upper retrievable packer in two-packer pumping hook-ups involving dual-zone pump. Set and released in same manner as Cross-over Snap Set packers above.

BAKER MODEL "E" RETRIEVABLE CASING PACKER

PRODUCT NO. 420-E

One of the shortest, most compact, set down retrievable packers available. Ideal for light or medium duty production requirements, or for all-around water flooding use. Simple J-Slot setting mechanism. Also available with hydraulically actuated button-type hold-down.

BAKER MODEL "A" RETRIEVABLE TENSION PACKER

PRODUCT NO. 739-A

One of the shortest, most modern high-performance tension packers. Ideal for economical low- or high-pressure water flooding. Rugged enough for many high-pressure fracturing and acidizing operations. Simple J-Slot setting mechanism.

BAKER
OIL TOOLS, INC.
HOUSTON
LOS ANGELES
NEW YORK

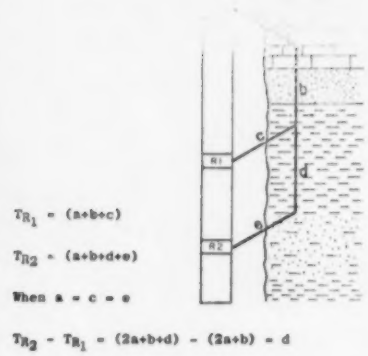


FIG. 7. **Mathematic cancellation** of mud path time. Dual receiver system measures time between two receivers (R_1 & R_2) and will effectively cancel the differences of the mud paths of the two receivers. While it can be shown that this is not a panacea in eliminating all borehole effects from changing size, it is obvious that it minimizes inaccuracies from this source.

as it approaches the shale section.

The single curve has the advantage of simplicity for general use and actually represents another log in much the same way that various spacings of resistivity and SP logs are combined in electrical logging. As mentioned earlier, the two-receiver log is considered the more accurate of the two curves. This is based upon the fact that time is measured between two points and that the mud path in the two-receiver version (Fig. 7) is mathematically cancelled.

Note in Fig. 7 that the time measured from the transmitter (T) to the first receiver (R_1) is shown as a + b + c. The time to the second receiver (R_2) may be shown as a + b + d + e. Subtracting the shorter path from the longer path we assume that a, c and e are equal. Substituting a for c and e leaves the resultant d as the time measured.

Visualize now a condition where borehole size does not remain constant between T and R_1 and R_2. If we are dealing only with the travel path between T and R_1 the borehole change in size would materially affect the time recorded. It would become longer or shorter and be a non-determinable factor in the use of the single receiver information. The two-receiver tool, however, will effectively cancel the differences of the mud paths of the two receivers. While it can be shown that this is not a panacea in eliminating all borehole effects from changing size, it is obvious that it minimizes inaccuracies from this source.

Another feature of this type log deals with the excursion time for a measurement in low velocity medium versus that in a higher velocity medium. The higher the velocity of the formation the less time required for the signal to reach the receivers. If the scale of the log is in linear time it becomes obvious that the excursion of the trace for velocity changes taking place in a relatively high velocity environment will be less, or to say it another way, the log will appear to have low amplitude or sensitivity. In low velocity environments, velocity changes within the formations will, of course, respond in the opposite manner. Fig. 8A and 8B show this characteristic by comparing portions of logs representing each condition. This can work to the disadvantage for the user of the log, particularly in areas where the formation velocities are high.

Porosity Study

Porosity studies under these conditions must be made with a relatively low sensitivity on the trace and the accuracy of interpretation may be somewhat hampered. In the velocity system this is overcome in two ways. One is to convert the linear time function to a linear velocity function when the logs are being used in high velocity materials. The result of this conversion is higher sensitivity or greater excursion of the recorder trace. The log is then easier and more accurate to work

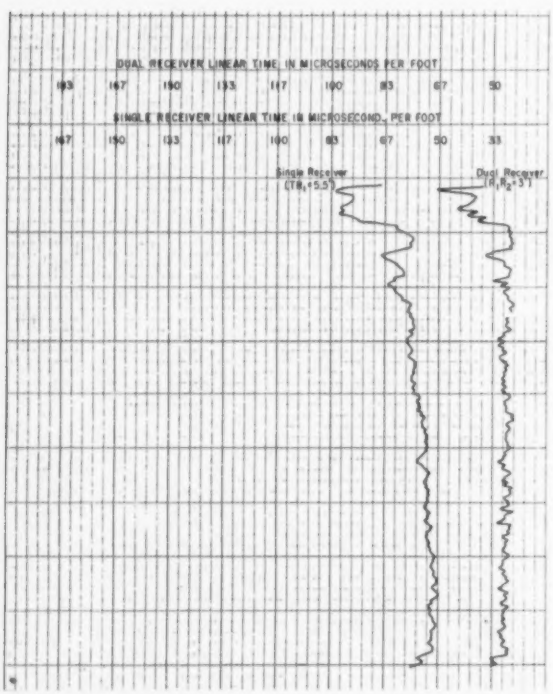

DUAL RECEIVER LINEAR TIME IN MICROSECONDS PER FOOT
200 167 150 133 117 100 83 67 50
SINGLE RECEIVER LINEAR TIME IN MICROSECONDS PER FOOT
167 150 133 117 100 83 67 50 33
Single Receiver
Dual Receiver

FIG. 8-A. **Characteristic response in high velocity** environments of standard linear time scale. Velocities of 19,000 ft per sec and above yield low sensitivity curve on linear time scale. Standard linear velocity scale would produce a high sensitivity curve (see Fig. 9-A).

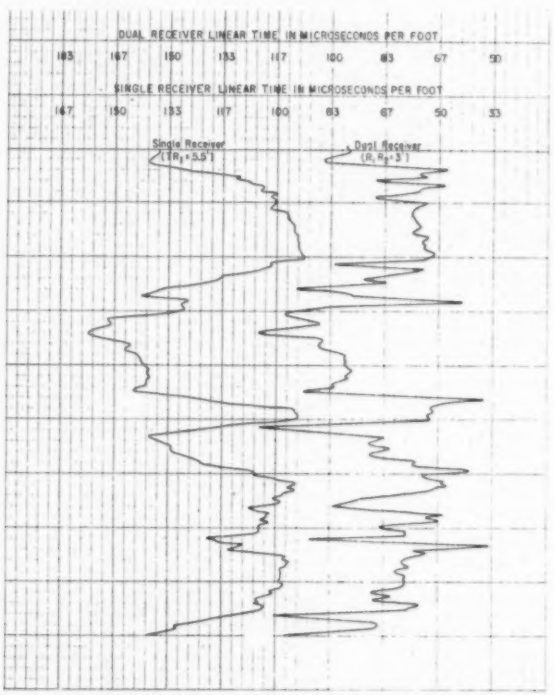

DUAL RECEIVER LINEAR TIME IN MICROSECONDS PER FOOT
200 167 150 133 117 100 83 67 50
SINGLE RECEIVER LINEAR TIME IN MICROSECONDS PER FOOT
167 150 133 117 100 83 67 50 33
Single Receiver
Dual Receiver

FIG. 8-B. **Characteristic response in low velocity** environments of standard linear time scale. Velocities of 7 to 15,000 ft per sec yield high sensitivity curve on linear time scale. Standard linear velocity scale would produce a low sensitivity curve in this range of velocities.

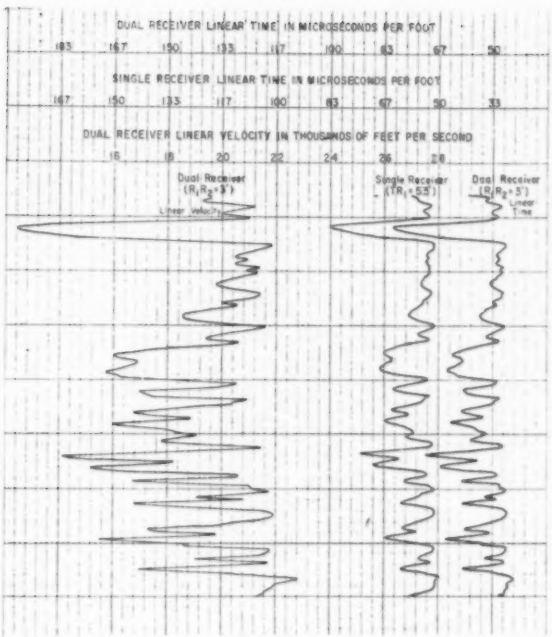

DUAL RECEIVER LINEAR TIME IN MICROSECONDS PER FOOT
SINGLE RECEIVER LINEAR TIME IN MICROSECONDS PER FOOT
DUAL RECEIVER LINEAR VELOCITY IN THOUSANDS OF FEET PER SECOND
Dual Receiver
Single Receiver
Dual Receiver
Linear Time

FIG. 9-A. **Linear velocity function** in high velocity material results in a higher sensitivity of the recorded curve making logs easier and more accurate for porosity studies.

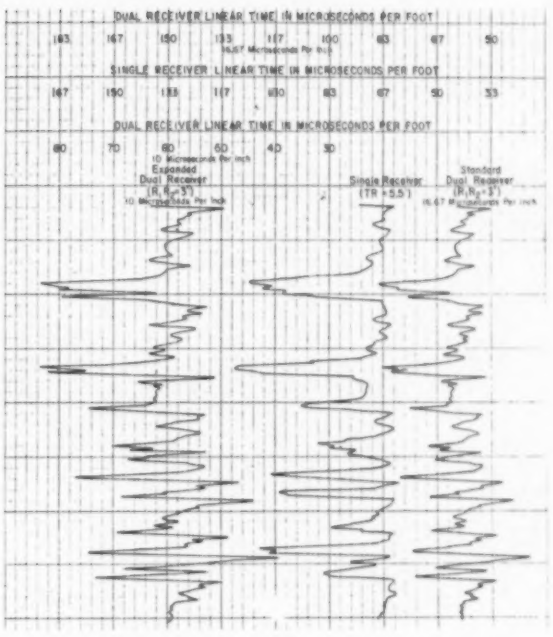

DUAL RECEIVER LINEAR TIME IN MICROSECONDS PER FOOT
SINGLE RECEIVER LINEAR TIME IN MICROSECONDS PER FOOT
DUAL RECEIVER LINEAR TIME IN MICROSECONDS PER FOOT
Expanded
Dual Receiver
Single Receiver
Standard
Dual Receiver

FIG. 9-B. **Expanding time scale** aids the accuracy of interpretation by increasing sensitivity in much the same manner as linear velocity scale does, but often hampers logging entire geo-acoustic spectrum without a number of scale shifts.

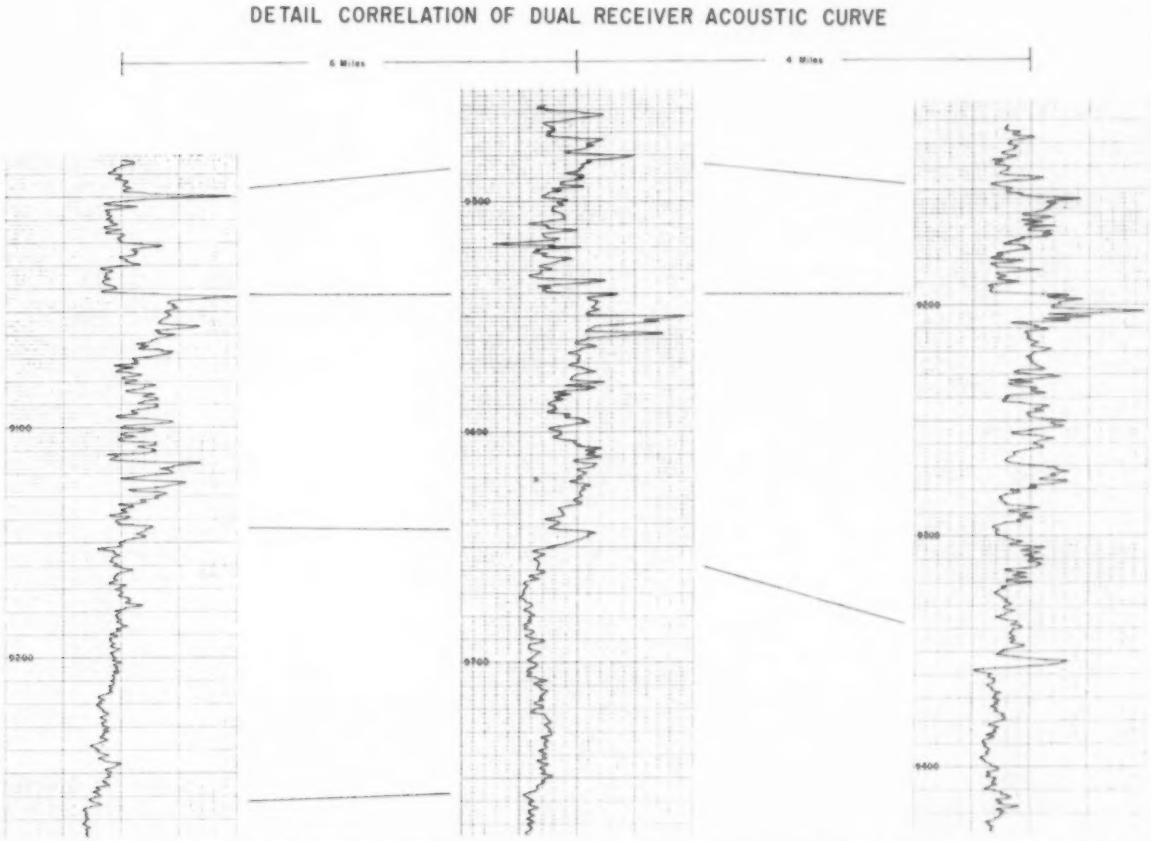


FIG. 10. **Dual receiver log.** While the single receiver log is the superior stratigraphic correlation curve, the dual receiver is the better detail correlation curve, and in this respect will probably be used most by engineers interested in a specific section within a well.

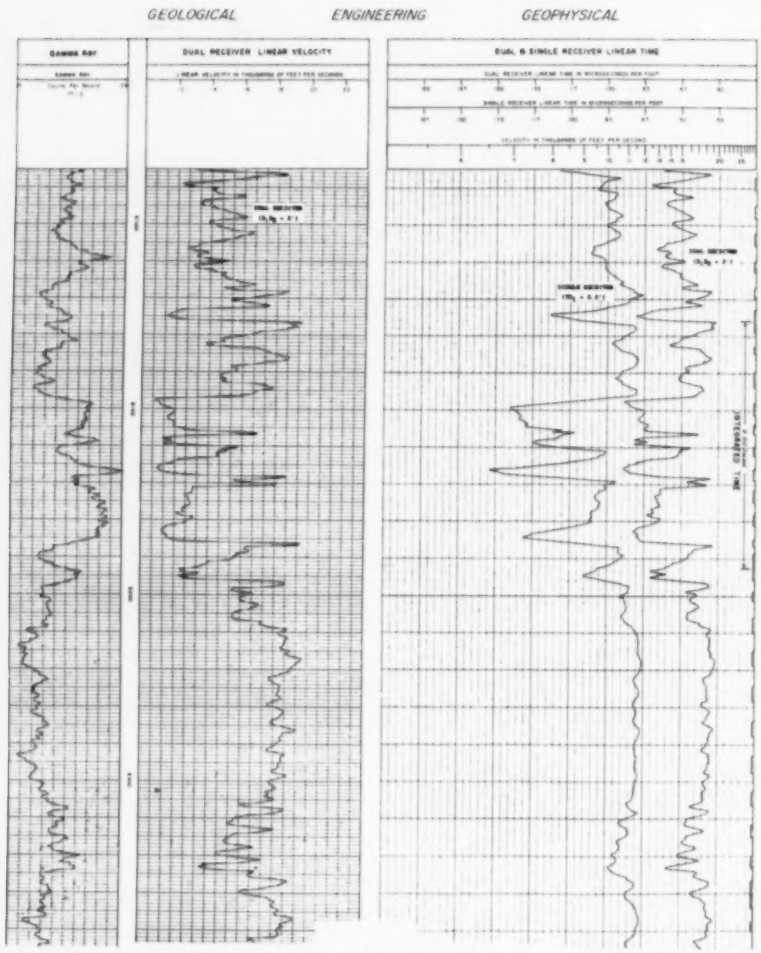


FIG. 11. **Reduced portion of a log** as run in the field showing the five simultaneous curves. This particular system offers a choice of 1, 2 or 3 ft dual receiver spacings.

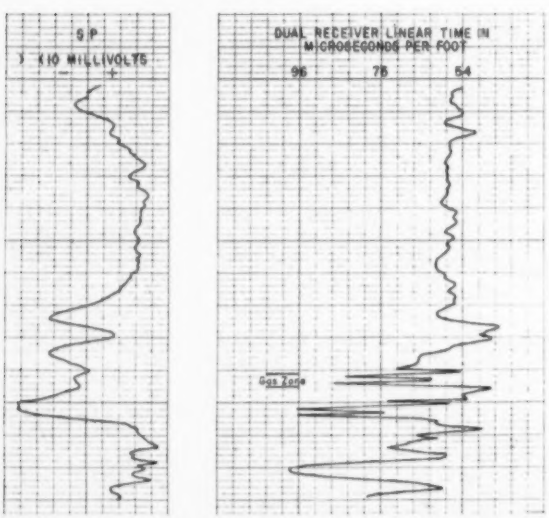


FIG. 12. **Velocity log of a typical gas zone.** The gas zone shown here tested 2.3 million cu ft per day.

with, particularly for determining porosities. The second method is to expand the time scale, leaving the log in the linear time function. This may be done by calibrating an expanded circuit to give even multiples of expansion or sensitivity. Fig. 9A and 9B are examples of these modes of presentation. Thus in this system a great deal of flexibility has been achieved to meet modern logging requirements and uses of the velocity logging techniques. This flexibility has resulted in improved and greater adaptability to the problems of geology and engineering while not penalizing the first users of the log, the geophysicists.

While the single receiver log is the superior stratigraphic correlation curve, the dual receiver is the better detail correlation curve, and in this respect will probably be used most by engineers interested in a specific section within a well. Fig. 10 demonstrates the two-receiver curve over a limited section wherein detailed correlation is desired. The dual receiver spacing provides a real physical measurement for any given spacing, as demonstrated in Fig. 7.

Variable Spacing

The Empire VS-acoustics system has been engineered to provide the desirable feature of permitting a selection of spacing between receivers of 1, 2 or 3 ft intervals. The problems of the engineer, geologist and geophysicist have further been considered in the design of this tool since spacing can be changed by a switching system in the

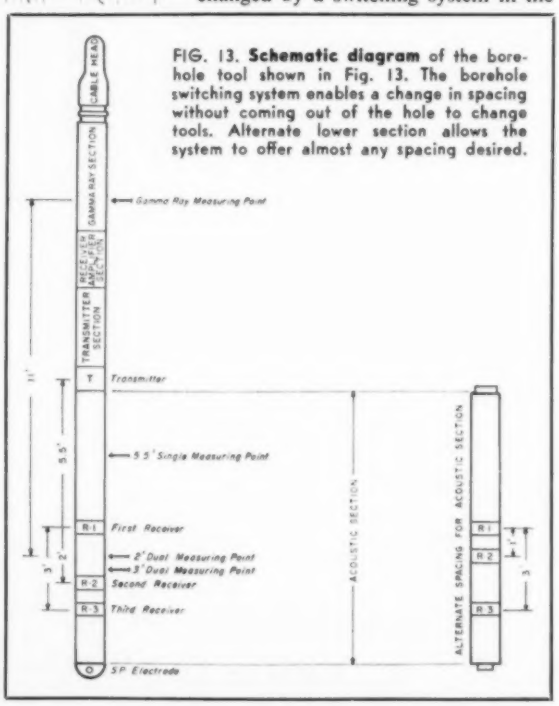


FIG. 13. **Schematic diagram** of the borehole tool shown in Fig. 13. The borehole switching system enables a change in spacing without coming out of the hole to change tools. Alternate lower section allows the system to offer almost any spacing desired.

When you hang Liners

USE BAASH-ROSS LINER HANGERS...

Types are available for every well condition!

Baash-Ross Liner Hangers — including plain type, regular action packing type, delayed action packing type, and Liner Hangers with hold-down slips, as well as setting tools and cementing manifolds — meet every requirement for safety in positive setting and, when necessary, effective cementing jobs.

Write for the new Baash-Ross technical manual on Liner Hangers which gives full information on all Baash-Ross Liner Hanger equipment and liner hanging techniques.

BAASH-ROSS DIVISION
OF JOY MANUFACTURING COMPANY

GENERAL OFFICES: 5306 CLINTON DRIVE, HOUSTON, TEXAS

AREA OFFICES:

Houston, Texas, Odessa, Texas, Dallas Texas; Long Beach, Cal.; Casper, Wyoming; Oklahoma City, Okla.; Olney, Ill.; Calgary, Alberta, Canada; New York, N. Y.

FOREIGN OFFICES:

Monte Carlo, Monaco; Mexico City, Mexico; Greenock, Scotland; London, England; Paris, France; Caracas, Venezuela; Buenos Aires, Argentina; Rio de Janeiro, Brazil; Tokyo, Japan

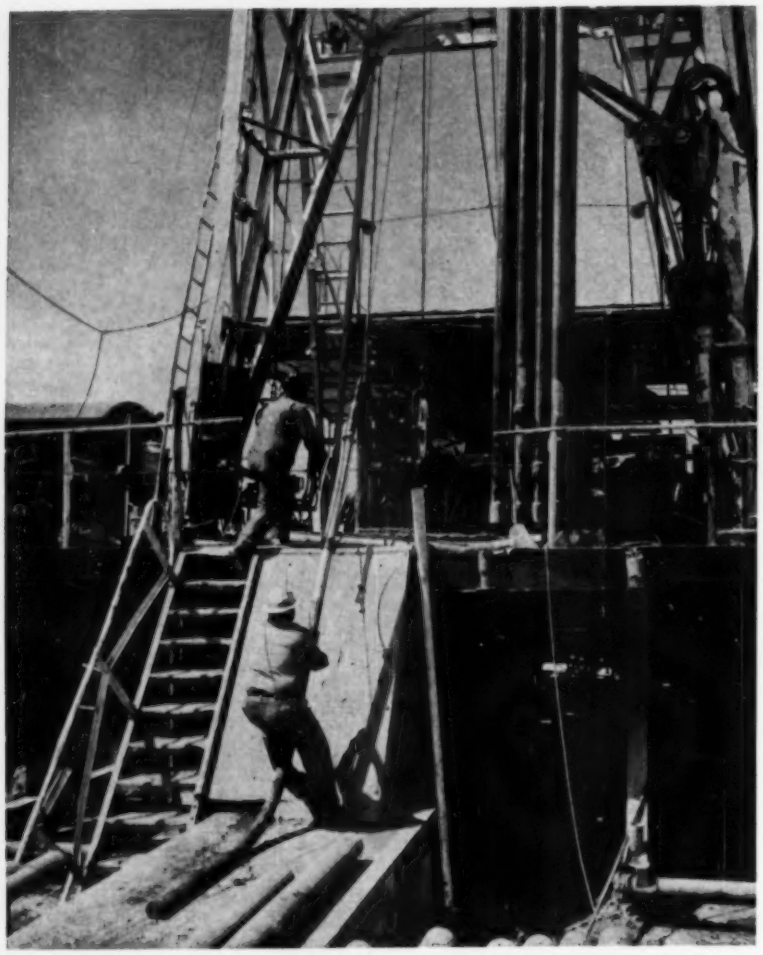


FIG. 14. **Logging tool** as it is being prepared to run in the hole. The acoustic receivers are housed in the flexible section at the bottom of the hole.

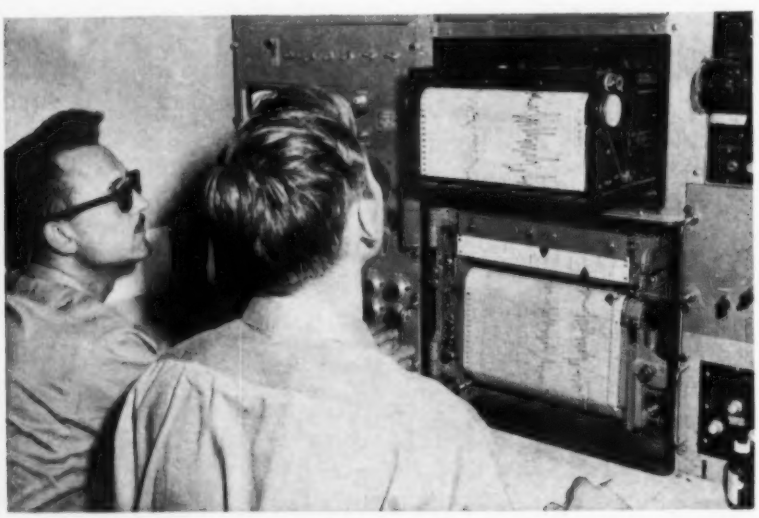


FIG. 15. **Acoustic log** as it is made in the field. This photograph shows the five curves of the log being recorded simultaneously. On the lower recorder are the simultaneous recording of integrated time, two receiver linear time, and single receiver linear time. On the upper recorder are the two-receiver linear velocity curve and the gamma ray curve.

borehole, thus enabling detailed section to be logged at short spacings while the overall, from total depth to top, can be logged at another selected spacing without coming out of the hole to change tools.

In order to provide lithological data and additional correlation information, the system is designed to simultaneously record either an SP or gamma ray. This is done by displaying the SP or gamma ray adjacent to an expanded time curve or a linear velocity curve, when run in high velocity environments. Fig. 13 is a schematic diagram of the borehole instrument.

Geological Markers

It is further interesting to note that the system incorporates the simultaneous recording of an integrated time curve. This curve is, of course, primarily of value when the information will be used for determining geophysical velocities. However, it is an aid in difficult zones where it is necessary to establish an average velocity over a portion of the section or for estimating average velocities to particular geologic markers.

Fig. 11 is a reproduction of an actual field log showing the five simultaneously recorded curves obtained on a single trip in the well. The example is shown with gamma ray on the far left, which can be alternated with an SP curve when desired. The information is recorded as two separate log charts in order to facilitate the multiple purpose usage of geologists, engineers and geophysicists.

Fluid Saturation Studies

The use of velocity logs in fluid saturation studies have proven most successful in the low velocity sand formations having high porosities, such as are generally found in the Gulf Coast areas. In the carbonaceous formations and formations of relatively high velocity and low porosity, very little success has been experienced to date. Fig. 12 is the portion of a velocity log showing a typical gas zone characteristic. It is believed that continued experience and research in the interpretation, instrumentation and general application of the velocity log will result in the discovery that its usefulness may exceed any one single family of logs yet derived.

Considerable economy may be achieved when it is recognized that some overlapping requirements for the various groups or users of logs may be satisfied by the use of the acoustic or velocity log in place of other logs. Where it is possible to meet the requirements of engineering, geological and geophysical personnel through elimination of duplicating logs, real economies do exist. ★ ★ ★

A permeability block method of . . .

Calculating a Water Drive Recovery Factor

The effect of permeability distribution is taken into consideration in mathematically determining ultimate recovery from a water drive reservoir as a function of water-oil ratio

T. G. Roberts
Norman J. Clark Engineering
Dallas, Texas

IN WATER DRIVE RESERVOIRS where the permeability is not uniform there is a tendency for the zones of higher permeability to water out first with zones of lesser permeability being only partially flushed by the time the reservoir has reached its economic limit. In determining the ultimate recovery from such reservoirs it is necessary to take this effect into consideration.

If the reservoir can be considered to be divided into several distinct layers of varying permeability which are continuous across the reservoir it will lend itself to a mathematical solution. The method presented in this article uses the Buckley-Leverett fractional-flow formula and rate-of-frontal-advance formula together with the Dykstra-Parsons equation to determine the recovery factor from a water drive reservoir as a function of the water-oil ratio.

Mathematical Solution

The recovery factor in barrels per acre-foot is calculated as a function of dimensionless time for each permeability group. Also, a dimensionless oil rate and water rate is calculated as a function of dimensionless time. Dimensionless time is used only to correlate the oil and water rates and recovery factor for each of the various permeability groups. From these data total oil and water rates, and therefore water-oil ratio, can be plotted against total recovery factor from all groups, and the recovery factor at the water-oil ratio corresponding to the economic limit can be read from this plot. An appropriate pattern efficiency factor should be applied to the recovery factor thus obtained.

Buckley-Leverett formula. The Buckley-Leverett[1] fractional-flow formula and rate-of-frontal-advance formula have been used for many years by reservoir engineers to predict water drive recovery from linear undersaturated systems. Various authors including Welge[2] and Pirson[3] have simplified the classic work done by Buckley and Leverett.

Basically this method assumes that

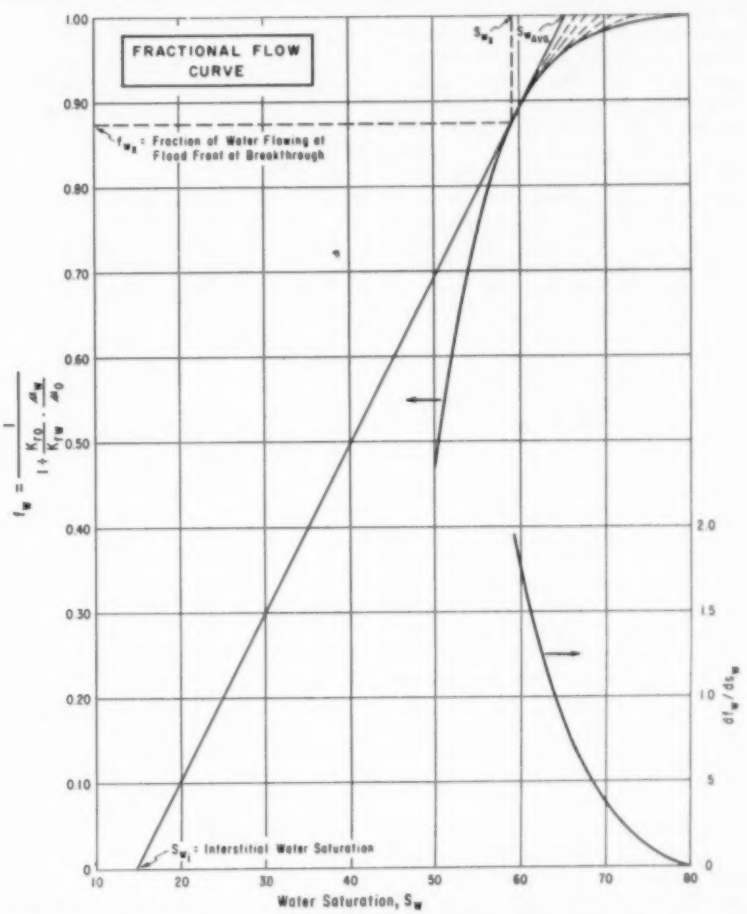


FIG. 1. **Fractional flow curve** shows relationship of fractional water flow (as a function of relative permeability and viscosity) and water saturation in sample solution.

TABLE 1. Core Analysis Distribution: Tensleep Reservoir, Wyoming.

Permeability Group	Permeability Range -md	Average Permeability K -md	Average Porosity ϕ -%	Samples in Group C -%	ϕ/K	(K)(C)	(0.7758)(ϕ)(C)
I	>100	181.3	15.9	8.5	0.0877	1541	104.8
II	50-100	69.0	15.0	10.9	0.2174	752.1	126.8
III	25-50	34.4	15.2	14.5	0.4419	498.8	171.0
IV	10-25	16.1	13.0	21.2	0.8075	341.3	213.8
V	<10	2.4	9.9	44.9	4.125	107.8	344.9

(1) a flood front exists, (2) no water moves ahead of the front, and (3) oil and water move behind the front. If the throughput is constant and the capillary gradient and gravity effects are neglected the fractional flow equation becomes:

$$f_w = \frac{1}{1 + \left(\frac{K_{ro}}{K_{rw}}\right)\left(\frac{\mu_w}{\mu_o}\right)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

This equation states that after breakthrough the fraction of the total flow stream at the outlet face of the sand body that is water, f_w, is a function of relative permeability. Since relative permeability is a function of water saturation, f_w is also a function of water saturation. The average water saturation, $S_{w_{avg}}$, behind the flood front at breakthrough can be obtained by constructing a tangent to the f_w versus S_w curve through the interstitial water saturation, S_{wi}, and reading $S_{w_{avg}}$ at $f_w = 1.0$. (See Fig. 1.) The water saturation at the outlet face, S_{w_x}, can be read from the curve at the point of tangency. The unit recovery factor at breakthrough for a given permeability group is then obtained from:

$$\text{U. R. F.} = (0.7758)\ (\phi) \times \left(\frac{S_{w_{avg}} - S_{wi}}{B_o}\right)\left(\frac{\%\ \text{samples}}{\text{in group}}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

in which ϕ is porosity in percent and B_o is formation volume factor.

Recovery subsequent to breakthrough may be calculated in a similar manner by constructing tangents to the fractional flow curve at successively higher values of f_w.

From Darcy's law the total oil rate of flow, Q_t, ahead of the front, where only oil is flowing, is:

$$Q_t = \frac{(\Delta P)\ (K_{ro})}{(\mu_o)\ (L)}(K \cdot A) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

In the Buckley-Leverett fractional flow equation the total fluid throughput is assumed to be constant. Therefore Equation 3 can represent, Q_t, for two-phase flow also.

In Equation 3 the cross-sectional area, A, can be considered as proportional to the "percent of samples," C, in a given permeability group. Also, the pressure differential across the flow path, ΔP, the length, L, of the flow path, the relative permeability, K_{ro}, and the viscosity, μ_o, are assumed to be the same for all permeability groups. Therefore, these factors can be neglected since interest is only in the relative rates in the different permeability groups. The total rate of fluid flow in dimensionless units can then be written as:

$$Q_t = (K)\ (C) \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and also in dimensionless units:

$$Q_o = (K)\ (C)\ (1 - f_w) \quad . \quad . \quad (5)$$

$$Q_w = (K)\ (C)\ (f_w) \quad . \quad . \quad . \quad (6)$$

The Buckley-Leverett rate-of-frontal-advance equation may be rearranged to give the time for a given displacing

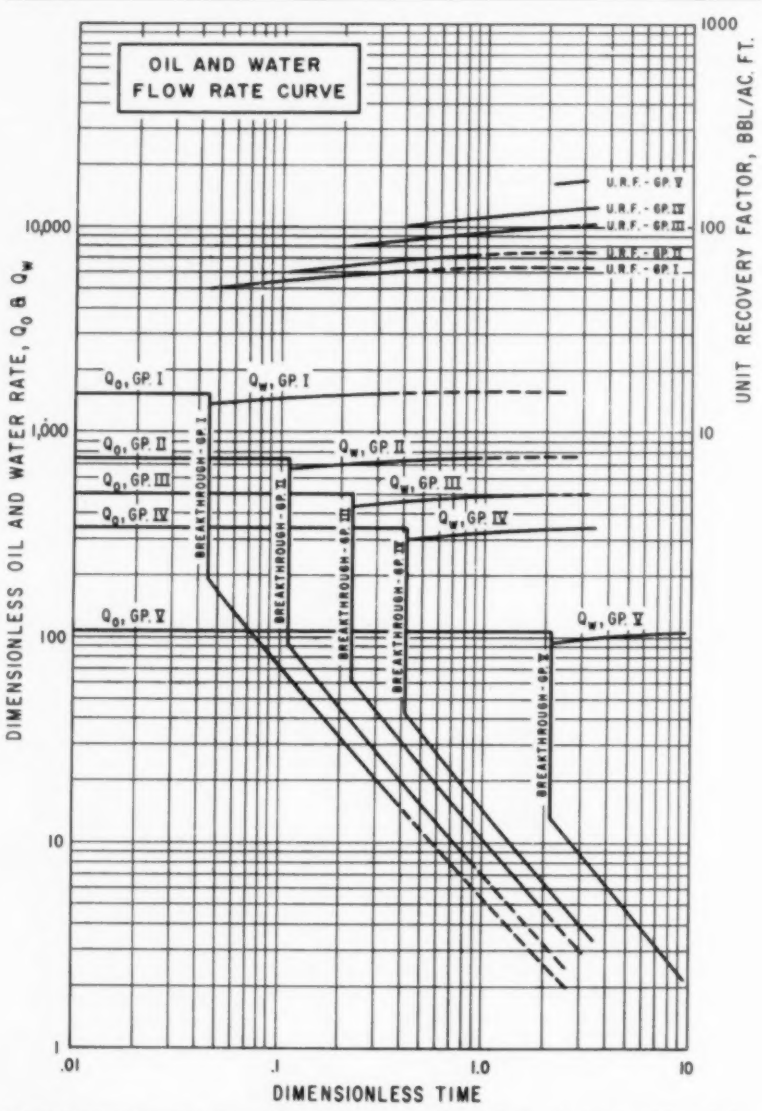


FIG. 2. **Flow rate curve** shows rate of oil and water flow before and after breakthrough for various permeability groups.

phase saturation to reach the outlet face of the sand body as follows:

$$t = \frac{(L)\ (A)\ (\phi)}{(Q_t)\ (df_w/dS_w)} \quad . \quad (7)$$

Substituting Equation 4 for Q_t and "percent of samples," C, for area, A, and neglecting L gives time in dimensionless units as:

$$t = \frac{(C)\ (\phi)}{(K)\ (C)\ df_w/dS_w}$$

or

$$t = \frac{\phi}{(K)\ (df_w/dS_w)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Dykstra-Parsons equation. The Dykstra-Parsons[4] equation is used to determine the position of the flood front in the remaining permeability groups when the preceding group of higher permeability is watered out. The fractional distance, Z, that the front has traveled in permeability group 2 when breakthrough has occurred in the next higher permeability group 1 is:

$$Z = \frac{\gamma - \sqrt{\gamma^2 + \frac{K_2}{K_1}(1-\gamma^2)}}{\gamma - 1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

where $\gamma = \frac{(K_{rw})\ (\mu_o)}{(K_{ro})\ (\mu_w)}$

The recovery from permeability group 2 at the time that breakthrough has occurred in group 1 is obtained by multiplying Equation 2 by Equation 9.

Example solution. To illustrate the method an example problem will be solved using the basic data from a Tensleep reservoir in Wyoming. Table 1 shows the core analysis distribution. Other basic data which are assumed to apply to all permeability groups are as follows:

Interstitial
water saturation = 15 percent

Formation
volume factor = 1.07

$$\text{Mobility ratio} = \frac{K_{rw}}{K_{ro}} \times \frac{\mu_o}{\mu_w} = 6.93$$

TABLE 2. Tabulation of Data for Sample Solution.

Fraction of Water Flowing, f_w	(Breakthrough) 0.875	0.900	0.920	0.940	0.960	0.980	0.990
S_{w_x}	0.592	0.605	0.619	0.638	0.658	0.692	0.725
$S_{w_{avg}}$	0.655	0.666	0.678	0.694	0.710	0.735	0.770
df_w/dS_w	1.950	1.630	1.360	1.050	0.770	0.430	0.230
$(1 - f_w)$	0.124	0.100	0.080	0.060	0.040	0.020	0.010
Group I (>100md)							
Q_o, Equation 5	191.1	154.1	123.3	92.5	61.6	30.8	15.4
Q_w, Equation 6	1348	1387	1418	1449	1479	1510	1526
t_{du}, Equation 8	0.045	0.0538	0.0645	0.0835	0.114	0.204	0.381
U.R.F., Equation 2	49.5	50.5	51.7	53.2	54.8	57.3	60.7
Group II (50–100md)							
Q_o	92.3	75.2	60.2	45.1	30.1	15.0	7.5
Q_w	658	677	692	707	722	737	745
t_{du}	0.111	0.133	0.160	0.207	0.282	0.506	0.945
U.R.F.	59.8	61.1	62.5	64.4	66.3	69.4	73.4
Group III (25–50md)							
Q_o	61.9	49.9	39.9	29.9	20.0	10.0	5.0
Q_w	436	449	459	469	479	489	494
t_{du}	0.227	0.271	0.325	0.421	0.574	1.03	1.92
U.R.F.	80.7	82.4	84.3	86.9	89.4	93.5	99.0
Group IV (10–25md)							
Q_o	42.3	34.1	27.3	20.5	13.7	6.8	3.4
Q_w	299	307	314	321	328	334	339
t_{du}	0.414	0.495	0.594	0.769	1.05	1.88	3.51
U.R.F.	100.9	103.1	105.4	108.6	111.8	116.9	123.8
Group V (<10md)							
Q_o	13.4	10.8	8.6	6.5	4.3	2.2	1.1
Q_w	94.3	97.0	99.2	101	103	106	107
t_{du}	2.12	2.53	3.03	3.93	5.36	9.59	17.9
U.R.F.	163	166	170	175	180	189	200

TABLE 3. Summary of Sample Solution.

Summary Table	Group I	Group II	Group III	Group IV	Group V	Total	Water-Oil ratio*
Breakthrough–Group I							
Unit recovery factor	49.5	14.5	9.3	5.4	1.1	79.8	
Oil rate, Q_o	191	752	499	341	108	1891	0.763
Water rate, Q_w	1348	—	—	—	—	1348	
Breakthrough–Group II							
Unit recovery factor	54.5	59.8	26.8	14.3	33	158.7	
Oil rate, Q_o	64	92	499	341	108	1104	2.07
Water rate, Q_w	1470	658	—	—	—	2128	
Breakthrough–Group III							
Unit recovery factor	58	65	80.7	31.1	6.6	241.4	
Oil rate, Q_o	27.5	40	62	341	108	578.5	4.93
Water rate, Q_w	1520	710	436	—	—	2666	
Breakthrough–Group IV							
Unit recovery factor	60.5	68	86	101	17.3	332.8	
Oil rate, Q_o	14.3	19.3	30.0	42.3	108	213.9	15.2
Water rate, Q_w	1541	735	465	299	—	3040	
Breakthrough–Group V							
Unit recovery factor	62.5	75	100	119	163	519.5	
Oil rate, Q_o	2.5	3.1	4.5	6.0	13.4	29.5	117
Water rate, Q_w	1541	752	499	334	94	3220	

*Stock Tank Conditions

Calculation Procedure:

(1) Segregate core analysis data into permeability groups and determine for each group: average permeability, average porosity and the percent of samples in the group as shown in Table 1. Also, the factors ϕ/K, (K) (C), and (0.7758) (ϕ) (C), which will be used later to calculate time, rate, and recovery, respectively, should be determined for each group.

(2) Construct fractional flow curve from Equation 1. Draw tangent to the curve through S_{w_i} as shown in Fig. 1.

(3) Draw tangents to fractional flow curve at successively higher f_w values after "breakthrough," and calculate df_w/dS_w and $S_{w_{avg}}$ corresponding to these f_w points.

(4) Construct df_w/dS_w versus S_w curve and read smoothed $\frac{df_w}{dS_w}$ values for Table 2.

(5) Calculate Q_o from Equation 5, and Q_w from Equation 6, corresponding to the chosen f_w points, for Table 2.

(6) Calculate time from Equation 8 and unit recovery factor from Equation 2, corresponding to the chosen f_w points, for Table 2.

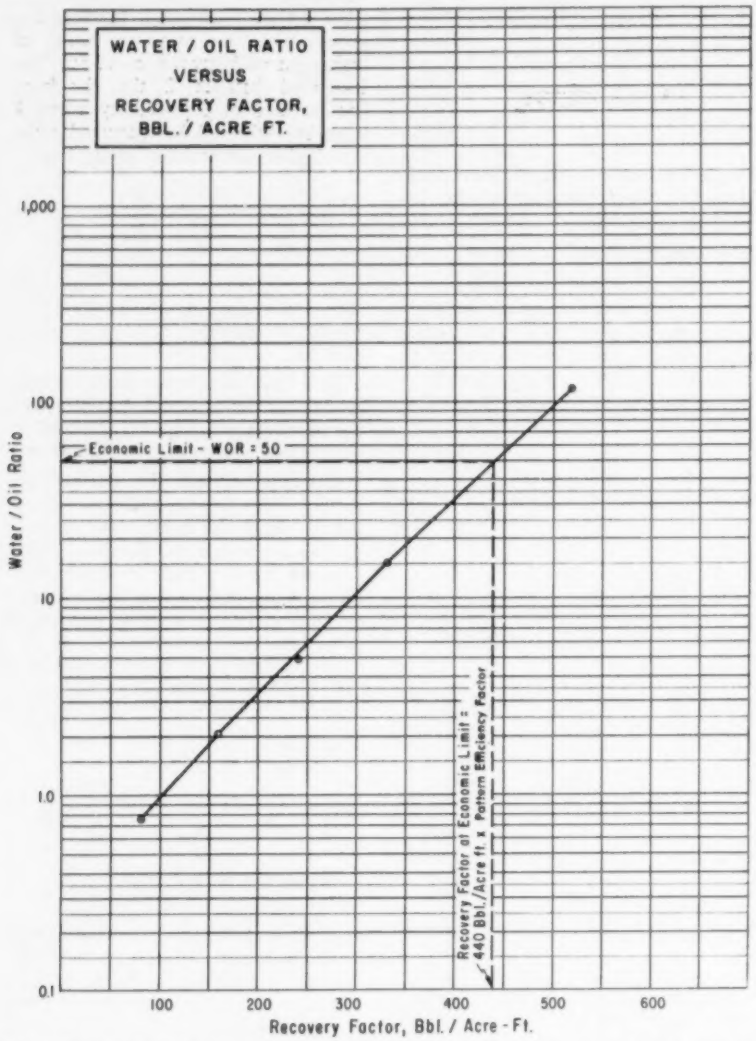


FIG. 3. **Recovery factor** is shown as a function of water-oil ratio for sample solution with economic limit at WOR = 50.

(7) Plot Q_o, Q_w and unit recovery factor versus time for all groups as shown in Fig. 2. Note that the oil rate prior to breakthrough is constant, since only oil is flowing, and is equal to (K) (C). Also, note that the water rate after breakthrough reaches a maximum equal to (K) (C) at $f_w = 1.0$ and is constant thereafter.

(8) Read the Q_o, Q_w and unit recovery factor values for all groups at time points corresponding to breakthrough at each successively lower permeability group and post in Table 3. The recovery for groups in which breakthrough has not yet occurred can be obtained by multiplying Equation 9 by Equation 2.

(9) Using the total Q_o and total Q_w at breakthrough of each permeability group, calculate water-oil ratio and plot it versus total unit recovery factor as shown in Fig. 3. Note that the water-oil ratio thus obtained is based on reservoir conditions and must be multiplied by the formation volume factor to convert it to stock tank conditions.

(10) Read recovery factor at the water-oil ratio corresponding to the economic limit.

(11) Multiply an appropriate pattern efficiency factor times the recovery factor from step 10 to obtain an average recovery factor for the reservoir.

Acknowledgment

The author wishes to express his appreciation to Mr. J. J. Arps, vice president of British-American Oil Producing Company, whose suggestions were the basis of this article.

References

1. Buckley, S. E. and Leverett, M. C.: "Mechanism of Fluid Displacement in Sand", *Trans.* AIME (1942), Vol. 146, p. 107.

2. Welge, H. J.: "A Simplified Method for Calculating Recovery by Gas or Water Drive," *Trans.* AIME (1952), Vol. 195, p. 91.

3. Pirson, S. J.: "Elements of Oil Reservoir Engineering", McGraw-Hill Book Company, Inc., New York, 1950, p. 285.

4. Dykstra, H. and Parsons, R. L.: "The Prediction of Oil Recovery by Water Flood" Secondary Recovery of Oil in the United States, Second Edition, API, New York, N. Y. (1950).

The Author

Thomas G. Roberts was graduated from the University of Oklahoma in 1950 with a bachelor of science degree in general engineering and was then employed by British-American Oil Producing Company, beginning his trainee program in the East Texas and South Texas fields. After serving 13 months in Korea with the Army Ordnance Corps, he completed his training program with B-A in the Oklahoma City field.

In August, 1953, he was transferred to B-A's Economics and Evaluation Department in Dallas as a petroleum engineer under J. J. Arps. His first major project in this department was the study of the expected recovery from solution gas drive reservoirs. Subsequent duties included evaluation of extensive properties purchased by British-American, making preliminary ultimate recovery estimates on newly-completed wells, preparation of company bulletins on interpretation of bottom hole pressure build-up data and quantitative interpretation of electric logs, appraisal of undeveloped acreage in connection with the preparation of bids for government land sales, and determination of the fair market value of various royalty interests and working interests.

In May, 1959, he joined Norman J. Clark Engineering, Dallas-based consulting firm. He is a registered professional engineer in Texas, a member of the Society of Petroleum Engineers of AIME, and a member of the Petroleum Engineers Club of Dallas.

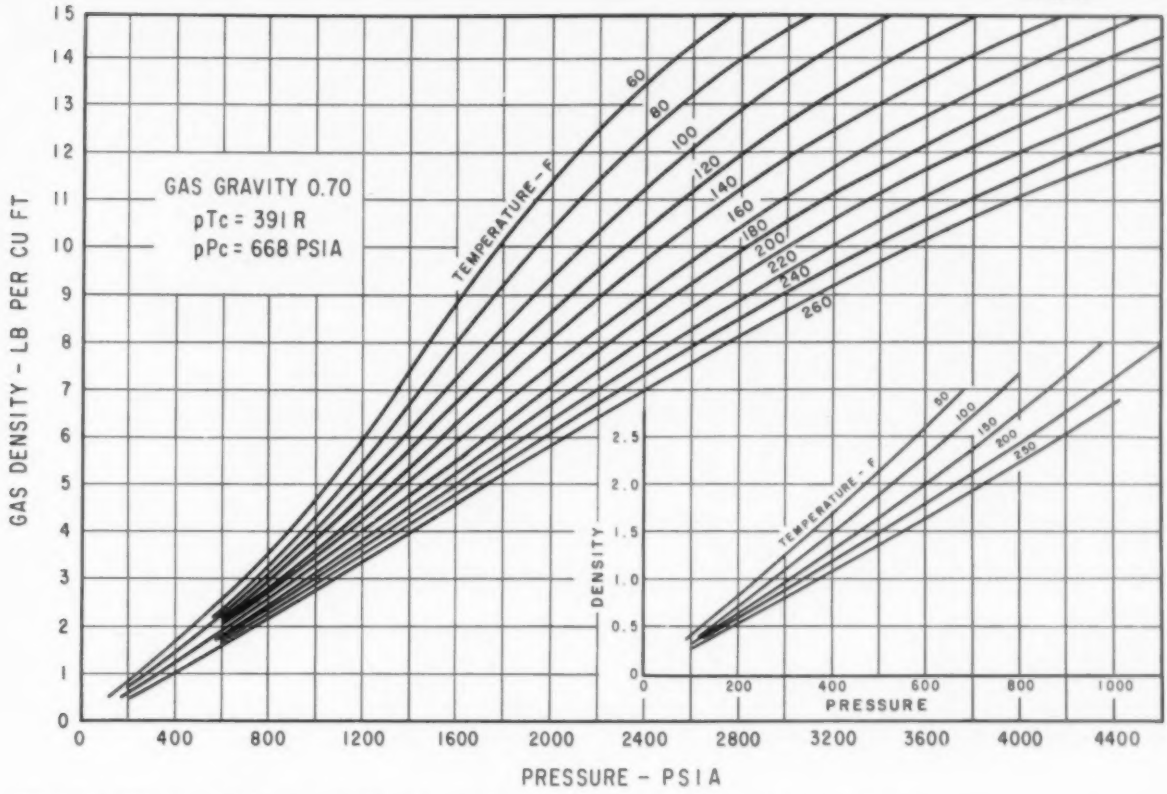


FIG. 1. Simplified graph of pressure-volume-temperature relationships of natural gas with gravity of 0.70.

A simplified method for . . .

Calculation of Gas Reserves from Gas Density Data

Use of gas density charts eliminates at least seven separate calculations from the conventional method of computing natural gas reserves

W. H. Mensch, *Engineer,*
Lone Star Producing Company,
Oklahoma City, Oklahoma

THE CONVENTIONAL VOLUMETRIC METHOD of computing natural gas reserves generally involves the application of correction factors in the form of pressure, temperature, and compressibility relationships to a basic acre-foot volume obtained by the use of average reservoir rock properties. Determination of these factors involves the use of gravity-critical value tables, compressibility factor charts, and the separate computation of pseudo-reduced states. Combined with the application of temperature, pressure, and recovery factors, and the need for a number of such determinations, this method can become unnecessarily tedious.

It therefore appears that a method that eliminates at least seven separate calculations and reduces time and effort by some 50 percent with no loss of accuracy would be extremely helpful, especially where a large number of these computations are required. Use of gas density charts as determined by M. B. Standing [1] provides such a method, and is the basis for the formulas and computations derived and described herein.

Development of Formula

Density correlations as presented by Standing are for 71 California gases, but were in agreement with similar determinations by Mathews, Roland, and Katz for 150 miscellaneous gases and 25 Oklahoma City gases. The resulting charts give density data which are usually in error by less than 3 percent. Unless the gas in question is known to contain appreciable quantities of nonhydrocarbon components,

1. Standing, M. B., *The Volumetric and Phase Behavior of Oil Field Hydrocarbon Systems*, Ch. 3, pp. 27-28. Rheinhold, 1952, New York.

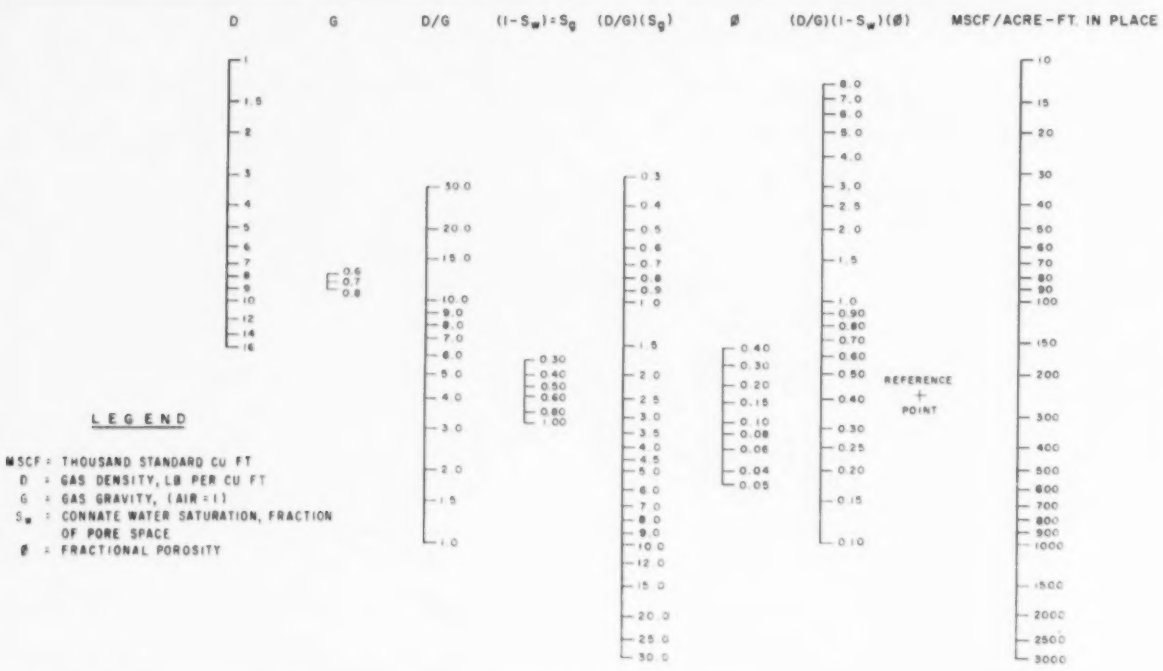


FIG. 2. Nomograph for determination of in-place gas reserves solves the equation $(D/G)(1-S_w)(\phi)(569.88)$.

confidence can be placed in the general use of these charts (Fig. 1).

Although Standing, through individual and stepwise computations, demonstrates a calculation of the volume at reservoir conditions occupied by one Mcf of surface gas, it was felt that the simplification and combination of these steps into one general formula would facilitate the use of these calculations. The method was therefore rearranged and combined with reservoir rock properties such that the in-place acre-foot gas reserves could be directly computed. Formula derived is as follows (for derivation and nomenclature, see appendix):

$$V = (569.88)\ (\phi)\ (1-S_w)\ (D/G) \quad . \quad . \quad (a)$$

Since the simplicity of the formula lent itself to nomograph solution, the required nomograph was constructed and is included as Fig. 2.

Because the calculation of gas reserves generally involves computation of recovery factor, a formula was also derived for this determination, using only the density correlations presented herewith. This calculation is given as:

$$\text{Recovery, fraction of gas-in-place} = \frac{D_i - D_a}{D_i}$$

. . . . . (b)

Derivation and nomenclature for this formula may also be found in the appendix.

The simplicity of this method derives primarily from the fact that determination of the gas density from the charts will automatically correct for given pressure and temperature, and compressibility factor as indicated by gravity of the gas. Thus, the value of gas-in-place may be determined by first obtaining density of the gas from the proper chart (interpolating linearly between charts, if necessary), dividing by gas gravity, and multiplying by fractional porosity, gas saturation, and the derived constant, 569.88. Where less accuracy is required the nomograph may be used for this calculation after density is determined. Recovery factor is obtained by determining the density at abandonment conditions and applying formula (b).

Sample Calculations

Solution with charts. The chart used herein is applicable to reservoir pressures up to 4600 psi and gas of 0.70 gravity. For the sample calculation we shall assume the following reservoir and gas properties:

$G = 0.70$
$P = 2500$ psia
$T = 150$ F
$\phi = 0.15$
$S_w = 0.25$

First step is to determine the density of the gas as:

From 0.70 gravity chart: $D = 9.75$ lb/cu ft at 2500 psia and 150 F. Next calculate gas in place per acre-foot, using $V = 569.88\ (\phi)(S_g)(D/G)$:

$$V = 569.88\ (0.15)\ (0.75)\left(\frac{9.75}{0.70}\right) = 893 \text{ Mcf/acre-ft}$$

Recovery factor at 400 psia abandonment pressure is determined as:

From density charts

$D_i = 9.75$ at 2500 psia and 150 F
$D_a = 1.28$ at 400 psia and 150 F

Therefore,

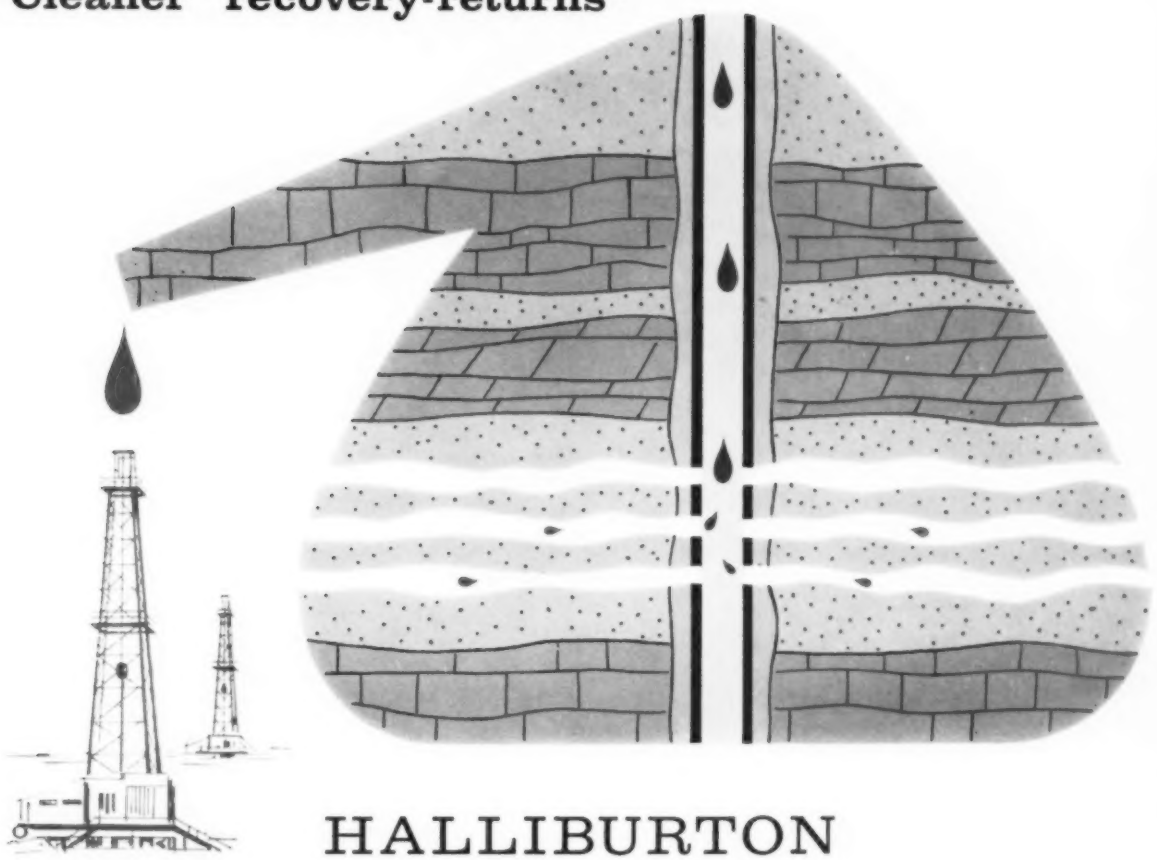
$$RF = \frac{9.75 - 1.28}{9.75} = 0.87$$

Thus, recoverable gas =

$0.87 \times 893 = 777$ Mcf/acre-ft

In the absence of a slide rule or calculator, the nomograph may be used with satisfactory results.

Cleaner "recovery-returns"



HALLIBURTON

CHEMFRAC

CHEMFRAC'S ability to return cleaner fluids from either shallow or deep wells after treatment, makes possible another fracturing advantage, in combination fracturing-acidizing stimulation.

CHEMFRAC utilizes a prepared emulsion of acid and kerosene, diesel oil or crude oil containing specially formulated additives, breaking with or without reaction of the acid phase. This combination mechano-chemical action gives especially effective results in limestones, dolomites and other calcareous formations.

CHEMFRAC Treatment offers greater fracturing flexibility because the formulation may be varied as needed in specific formations . . . at either high or low temperatures . . . with the breaking characteristics accelerating after placement of fluid.

Investigate Chemfrac Today . . . ask your local Halliburton Representative about Chemfrac's successful use and how it may help you. Also ask about the many other Halliburton Production Stimulation Treatments that are available.

CHEMFRAC makes possible these added mechano-chemical advantages:

- Cleaner "recovery-returns"
- Superior sand carrying ability
- Lower frictional resistance

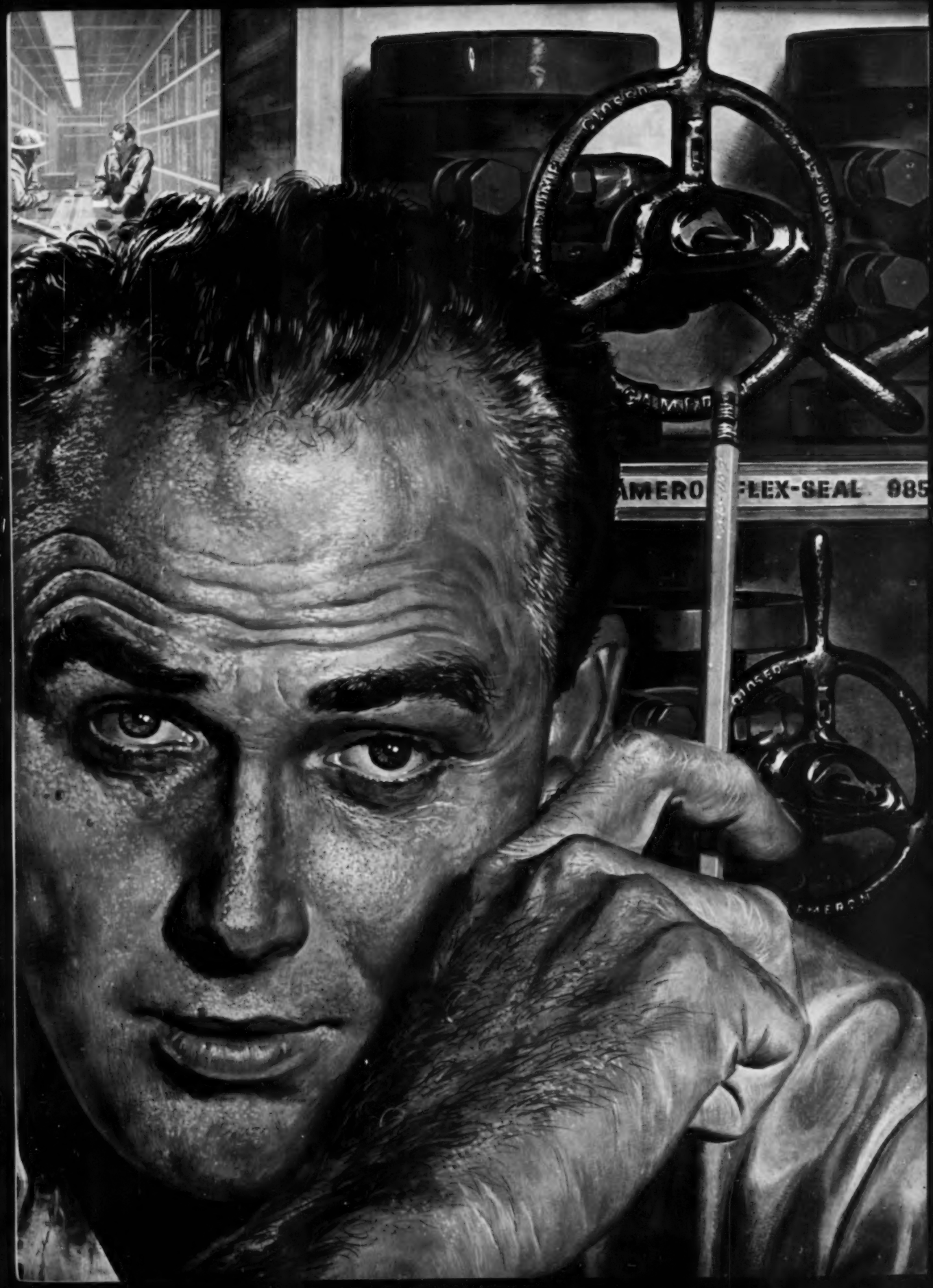
CHEMFRAC does not contain arsenic or chlorinated hydrocarbons.

HALLIBURTON
Fracturing Services

"For research and results in formation fracturing"

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

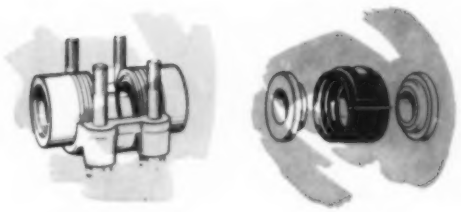
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD


FLEX-SEAL

"... CAMERON FLEX-SEAL, MOST POPULAR VALVE FOR MUD LINE SERVICE"

The reason for this remarkable record is Cameron's exclusive design – a basic design which was an immediate success with drillers all over the world. The Cameron Flex-Seal was designed to control the cutting action of abrasive-laden fluid under high pulsating pressure. Over twenty years after its introduction the Flex-Seal is still the favorite of smart operators everywhere – the valve most often asked for in supply stores. Rugged dependability, extra long service, and easy repair spell performance that can't be beat.

Extended cap nuts protect the all important stud threads from abrasion and corrosion, make bonnet removal extra easy in any position. Gate and stem are one solid forging, give perfect alignment with no wobble to increase wear. The only mud valve gate with a shoulder – affords energizing of packer. Rubber cannot flow past on tight closures.



Integral welded subs and body cap make misalignment during repairs impossible. If a sub is damaged it may be separated and replaced rather than replacing an expensive body unit. Tough compound in the big gate packer means lots more wear, easier repairs. Replacements require no special instructions or fixtures – no intricate positioning of gate stem threads. The oversize carburized steel wear rings are sealed against the subs by "O" rings and are removed straight out with the gate packer as a unit.

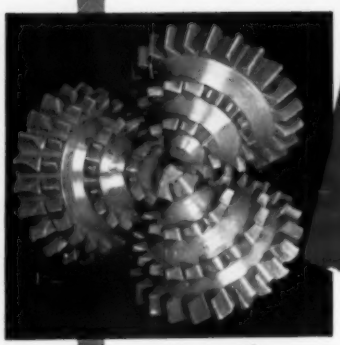
Flex-Seals are manufactured in the United States, England, and France. They are available in supply stores throughout the world.

Cameron

IRON WORKS, INC.

P. O. Box 1212 – Houston, Texas

Export Office: 7912 Empire State Bldg., New York City. In England: Cameron Iron Works Ltd., 76 Grosvenor St., Loggon W. 1 England



SECURITY makes the **RIGHT BIT** for the Job!

For Hard Formation Drilling...

specify SECURITY "H" SERIES Bits

276 { TYPES, SIZES AND VARIATIONS

SECURITY makes a complete line of rock bits — more than 1120 types, sizes and variations. Of these, 276 are supplied exclusively for HARD FORMATION drilling.

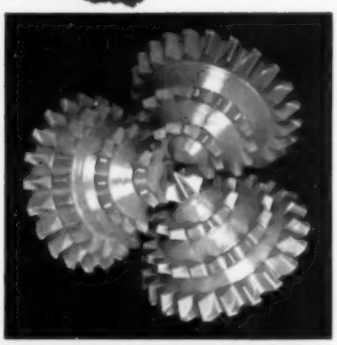
Like all Security bits, "H" SERIES *hard formation* rock bits can be obtained for either regular, jet, air, or jet-air circulation. Whatever your specific drilling requirements, specify Security and get the *right* bits for every well you drill. You will find — as thousands of others have — that Security rock bits lead in quality construction and modern design features, and are first choice for use under present-day drilling requirements.

Complete data about Security rock bits and drilling tools are contained in the 1959 catalog. Write today for your free copy.

↑H7

FORMATION RATINGS: For hard semi-abrasive sand, hard lime with chert streaks, dolomite, etc.

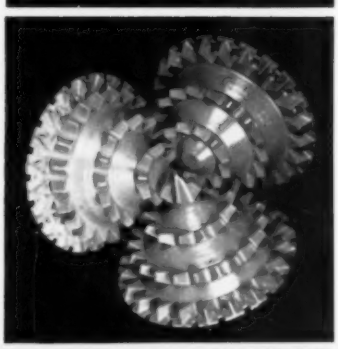
SIZES: 23 bit sizes from 5⅝ inches to 12¼ inches



H7L→

FORMATION RATINGS: For hard-abrasive consolidated sandy limestone, chert-bearing limestone and dolomite, and other hard-abrasive strata.

SIZES: 6 bit sizes from 7⅞ inches to 12¼ inches



H7W→

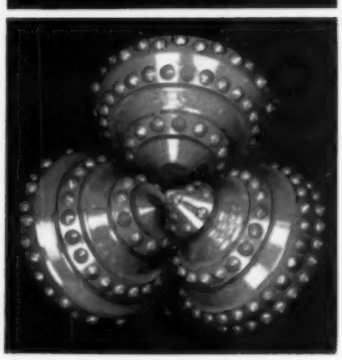
FORMATION RATINGS: For extremely hard and abrasive chert, schist, sand rock, quartzite, pyrite and granite.

SIZES: 23 bit sizes from 5⅝ inches to 12¼ inches

H9→

FORMATION RATINGS: For very hard, brittle, extremely abrasive chert, flint, taconite, quartzite and basalt.

SIZES: 10 bit sizes from 6⅛ inches to 12¼ inches

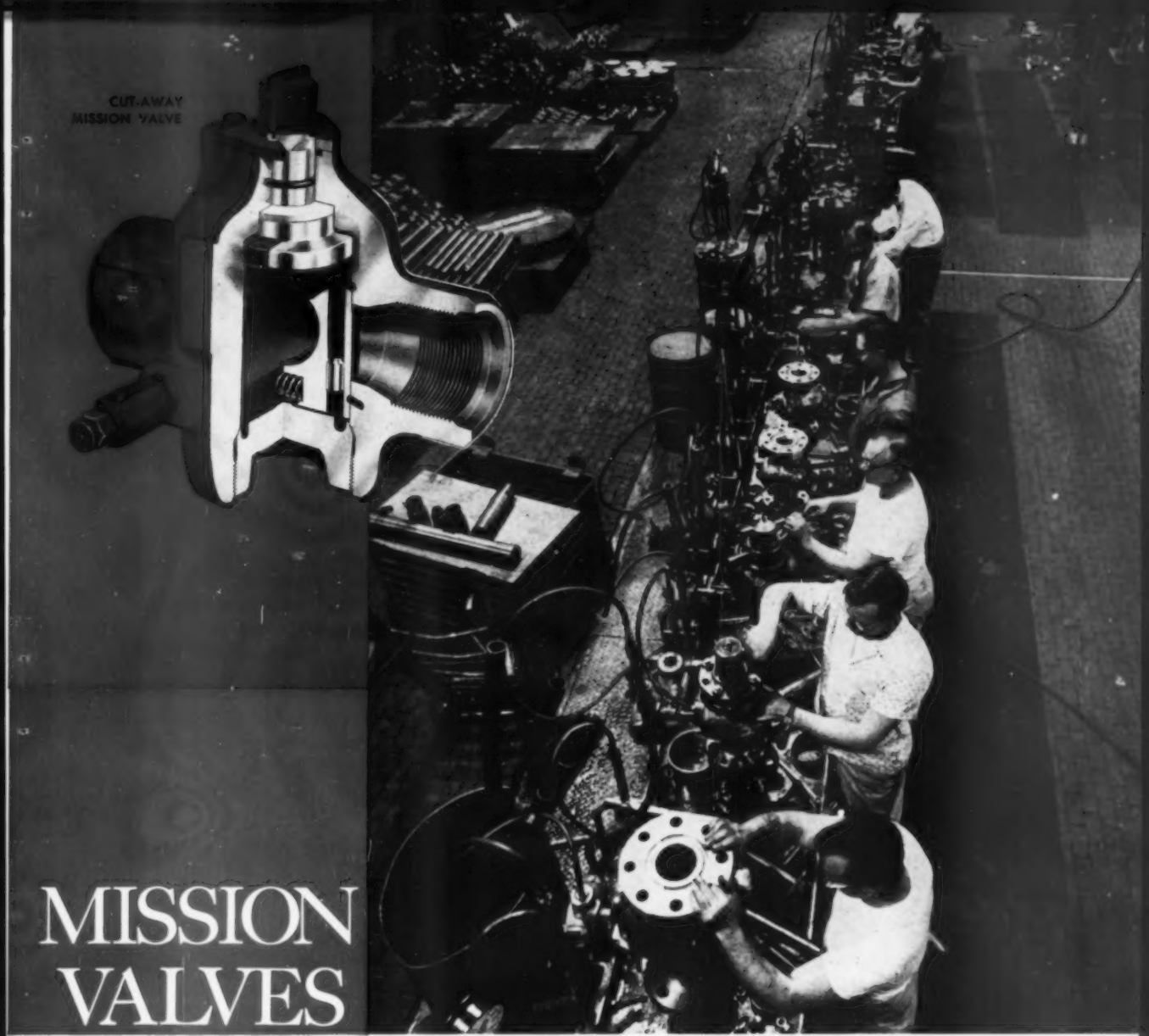


Security

PRECISION BITS SINCE 1931

PLANTS... Dallas, Texas; Wellton, California; Manchester, England
SECURITY ENGINEERING DIVISION... 3400 W. Illinois, Dallas, Texas
EXPORT OFFICE... Post Office Box 13647, Dallas, Texas
CANADA... Security Engineering Canada, Ltd., Edmonton, Alberta, Canada
OVERSEAS... Security International C. A., Caracas, Venezuela; London, England

Available through Your Favorite Accredited Supply Store



MISSION VALVES

protect you with a seal that works for you

Line pressure actually seals Mission Valves more tightly. The greater the pressure against the closed valve, the more tightly Mission Sealant holds—acting like a plastic packing. This automatic sealant injection system literally stops leaks before they start. This basic design, constantly improved upon, has been proved by almost twenty years in the field. Backed up by the modern manufacturing techniques of Mission's new Houston plant, you know you're getting quality. These are the reasons Mission Valves do what they're supposed to do, and do it for years with very little maintenance. There are more than 315 different valves, bringing the positive advantages of the Mission Valve to practically every application. Specify Mission and eliminate your valve problems.

For over thirty years-quality built in to last

MISSION MANUFACTURING CO.

MISSION MANUFACTURING CO., P. O. BOX 4209, HOUSTON, TEXAS • CABLE ADDRESS—"MISSCO"
EXPORT OFFICE: 30 ROCKEFELLER PLAZA, NEW YORK • IN THE UNITED KINGDOM: MISSION MANUFACTURING CO., LTD., 17 HANOVER SQUARE, LONDON W. 1 ENGLAND • CABLE ADDRESS—"MISSOMAN"
PISTONS • PISTON RODS • SLIPS • GLAND PACKINGS • LINERS • LINER PACKING
PUMP VALVES AND SEATS • SWABS • VALVES • HAMMERDRILS • CENTRIFUGAL PUMPS

59-202

W. H. Mensch *is an engineer for Lone Star Producing Company in Oklahoma City, Oklahoma. A graduate of the University of Texas with a B.S. in Petroleum Engineering, he was employed by Lone Star in 1955. After serving as a production engineer in the East Texas district at Athens, Texas, he was moved to the home office in Dallas in 1956, where his duties consisted of general production engineering and reservoir and evaluation work. Much of this work involved the estimation of producing oil and gas reserves and periodic revisions to maintain the current status of these reserves for both Lone Star Producing Company and Lone Star Gas Company. In 1958, he was transferred to the Oklahoma District Exploration office in Oklahoma City, where his work has consisted primarily of secondary recovery and evaluation work.*

Solution with formula. For the sake of comparison, the same problem will be solved using the conventional formula,

$$V = 43{,}560\ (\phi)\ (S_g)\ (F_t)\ (F_p)\ \frac{1}{Z}$$

${}_pP_c$ for 0.70 gravity gas = 668 psia
${}_pT_c$ for 0.70 gravity gas = 392 R

$$P_r = \frac{2500}{668} = 3.74$$

$$T_r = \frac{150 + 460}{392} = 1.56$$

From Z charts, $Z = 0.799$, $\frac{1}{Z} = 1.252$

$$F_p = \frac{P}{P_b} = \frac{2500}{14.65} = 170.65$$

$$F_t = \frac{T_b}{T} = \frac{520}{150 + 460} = 0.852$$

Therefore,

$$V = 43{,}560\ (0.15)\ (0.75)\ (170.65)\ (0.852)\ (1.252) = 892 \text{ Mcf/acre-ft}$$

At 400 psia, $P_r = \frac{400}{668} = 0.600$, $Z = 0.947$

$$RF = \frac{\frac{2500}{0.799} - \frac{400}{0.947}}{\frac{2500}{0.799}} = \frac{3129 - 422}{3129} = 0.87$$

Thus, recoverable gas = $0.87 \times 892 = 776$ Mcf/acre-ft

It is seen that both methods give precise results although the latter involved many more individual operations in performing the calculation.

Conclusions

Use of gas density charts for determination of in-place and recoverable reserves gives data which are in excellent agreement with results of conventional methods of computation. The method described herein, however, involves less individual operations in carrying out the calculation and is particularly suited to simple nomograph solution. General use of this method should offer a reduction of effort and time in making these estimates, especially those of a preliminary nature where many such determinations are required.

APPENDIX

Nomenclature

Symbols used throughout this paper are:

- Mscf = Thousand standard cubic feet (14.65 psi and 60 F)
- V = Volume in Mscf
- G = Gravity of gas, air = 1
- P = Pressure, psia
- T = Temperature, deg R or F as indicated
- D = Gas density, lb per cu ft (actual)
- ${}_pP_c$ = Pseudo-critical pressure, psia
- ${}_pT_c$ = Pseudo-critical temperature, R
- P_b = Base pressure, 14.65 psia
- T_b = Base temperature, 520 R
- P_r = Reduced pressure
- T_r = Reduced temperature
- Z = Compressibility factor
- F_p = Pressure correction factor
- F_t = Temperature correction factor
- a = Subscript indicating abandonment conditions
- i = Subscript indicating initial conditions
- th = Subscript indicating theoretical values (ideal gas)
- ϕ = Fractional porosity
- S_w = Connate water saturation, fraction of pore space
- S_g = Gas saturation, fraction of pore space $(1 - S_w)$, oil saturation assumed to be zero.

Derivations

Gas-in-place formula

To derive the basic formula, the weight of one Mscf of gas is determined as follows:

lb-moles per Mscf = $\frac{1000}{379}$

lb per lb-mole = G times mole-weight of air = 28.97 G

Thus, lb of gas per Mscf = $\frac{1000}{379} \times 28.97G = 76.438G$ . . . . . (1)

If (1) is now divided by density at reservoir conditions in lb per cu ft, the volume at reservoir conditions in cu ft which is occupied by one Mscf is obtained. Mathematically this is,

$$\frac{76.438G}{D} \quad . \ . \ . \ . \ . \ . \ . \ . \ (2)$$

Since the reservoir volume available to gas saturation is $43{,}560\ (\phi)\ (1 - S_w)$ cu ft per acre-ft, the expression

$$\frac{43{,}560\ (\phi)\ (1 - S_w)}{76.438\ (G/D)}$$

will give Mscf gas in place per acre-ft. Simplifying the fraction gives,

$$V = 569.88\ (\phi)\ (1 - S_w)\ (D/G) \quad . \ . \ . \ (3)$$

Recovery factor formula

The value of recovery factor is commonly determined by the formula,

$$\frac{P_i/Z_i - P_a/Z_a}{P_i/Z_i} \quad . \ . \ . \ . \ . \ . \ (4)$$

The relation between Z and D is derived as:

$$Z = \frac{V}{V_{th}} \quad \ldots\ldots\ldots \quad (5)$$

$D_{th} = \frac{M}{V_{th}}$ and $D = \frac{M}{V}$, where M = weight of gas

Therefore,

$$\frac{D_{th}}{D} = \frac{M/V_{th}}{M/V} = \frac{V}{V_{th}} = Z \quad \ldots\ldots\ldots \quad (6)$$

From the perfect gas law:

$\bar{V} = \frac{RT}{MP}$ where: $\bar{V}$ = specific volume
R = gas constant
M = molecular weight of gas

Thus, $D_{th} = \frac{1}{\bar{V}} = \frac{MP}{RT}$

Since M = 28.97G and R = 10.73 $\ldots\ldots$ (7)

$$D_{th} = \frac{28.97GP}{10.73\ T} = \frac{2.7GP}{T}$$

Therefore,

$$\frac{D_{th}}{D} = Z = \frac{2.7GP}{D\ T} \quad \ldots\ldots\ldots \quad (8)$$

Substituting in eq. (1) gives,

$$RF = \frac{\frac{P_i}{(2.7GP_i/D_iT)} - \frac{P_a}{(2.7GP_a/D_aT)}}{\frac{P_i}{(2.7GP_i/D_iT)}}$$

Simplifying, $RF = \frac{\frac{D_iT}{2.7G} - \frac{D_aT}{2.7G}}{\frac{D_iT}{2.7G}}$, gravity and temperature

terms multiply out leaving, $RF = \frac{D_i - D_a}{D_i}$ $\ldots\ldots$ (9)

Density Correlations for Gas Reserve Calculations

1. Obtain density (D_i) at initial conditions from proper charts, interpolating linearly between charts when necessary.
2. Multiply D_i by fractional porosity (ϕ), fractional gas saturation ($S_g = 1 - S_w$), and the constant 569.88, and divide by gravity (G). Result is gas-in-place in Mcf per acre-ft.
3. Obtain density (D_a) at abandonment conditions using charts as in (1).
4. Subtract D_a from D_i and divide by D_i. Result is recovery factor, fraction of gas-in-place.
   Mathematically, the formulas are written as:
   a) $V = 569.88\ (1 - S_w)\ (\phi)\left(\frac{D}{G}\right)$, for gas-in-place
   b) $RF = \frac{D_i - D_a}{D_i}$, for recovery factor.

* * *

'Modern Well Completion' Lectures Offered at University of Texas

The University of Texas, Austin, is again offering its highly popular seminar course in Petroleum Engineering 270. Subject for the course, to be offered during the first semester of the regular 1959-60 scholastic year, is "Modern Well Completion."

As in past years, the class will meet from 4 to 6 Monday evenings in Room 115, Experimental Science Building. No room in the Petroleum Engineering building is large enough to accommodate the usual enrollment in the class.

Since service companies are engaged in most phases of well completion, the lectures will be presented by qualified individuals in each field, as selected by service company management. Three of the lectures, however, will be presented by oil company personnel. Dr. Paul D. Torrey, who organized the Atlantic Lectures of The University of Texas series last year, has also been responsible for this series of lectures. The entire program is under the direction of Dr. George H. Fancher, head of the university's department of petroleum engineering.

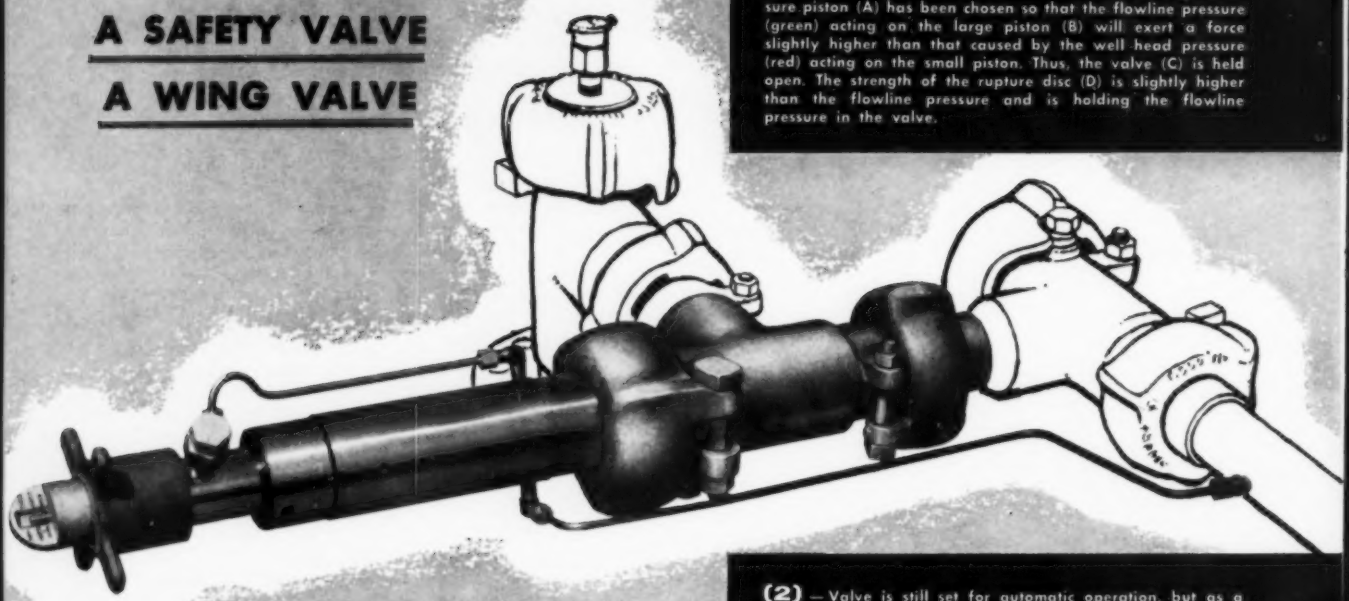
Registration for the course is September 21.

On September 28, the course will be opened by informal addresses by L. B. Meaders, president of Halliburton Oil Well Cementing Company; E. F. Stratton, vice president of operations, Schlumberger Well Surveying Corporation; and Ott Hammer, operating vice president, Dresser Industries, Inc.

Schedule for the course has been outlined as follows:

September 21	Class Registration
September 28	Introductory Lectures
October 5	Class does not meet
October 12	Conditioning Mud for Well Completion, Orien Van Dyke, Magnet Cove Barium Corporation
October 19	Electric Logging of Wells, W. P. Biggs, Schlumberger
October 26	Electric Log Interpretation (at the well), R. P. Alger, Schlumberger
November 2	Radioactive Logging of Wells, Lane-Wells
November 9	Radioactive Log Interpretation (at the well), Lane-Wells
November 16	Drillstem Tests, Cecil R. Richardson, Halliburton
November 23	Design of Casing Strings and Running Casing, J. F. Hendrickson, Gulf Coast Assistant Superintendent, Phillips Petroleum Company with G. C. Watson as alternate.
November 30	Cementing Practices, Phil Montgomery and Dwight Smith, Halliburton
December 7	Perforating Casing, Lane-Wells
December 14	Formation Fracturing, W. E. Hassebroek and C. D. Saunders, Halliburton
January 4	Chemical Treatment and Well Stimulation, Francis N. Harris, Halliburton
January 11	Multiple Zone and Permanent Type Completions, T. A. Huber, Chief Petroleum Engineer, Humble Oil and Refining Company
January 18	Running Tubing, Surface Connections, Control of Initial Production, Potential Tests, Lewis Finch, Chief Engineer, Pan American Petroleum Corporation
January 25	Final Examination.

A SAFETY VALVE
A WING VALVE



UNIBOLT *Pressurematic*
Balanced Piston VALVE

It is entirely pressure operated—*no springs.*

It automatically protects flowlines, separators, treaters and other equipment against high well pressures.

It automatically shuts in the well in case of a broken flowline or failure of any equipment in the gathering or treating system.

It serves the *dual* purpose of a Christmas tree wing valve and an automatic safety valve. As a wing valve, a few turns of the hand-wheel opens and closes it. Or, set the hand-wheel in automatic position and it's a high-low safety valve.

It uses the time-tested fundamental engineering principle of balancing a large piston which is exposed to low pressure (flowline) against a small piston which is exposed to high pressure (well head). Any fluctuation in these pressures will disturb the balanced pistons and cause the valve to close.

The automatic assembly is stainless steel throughout and may be readily adapted to any UNIBOLT 2" Wing Valve or Choke Body.

It is economical, and saves the cost of one valve.

Completely descriptive literature gladly sent on request.

THORNHILL UNIBOLT **CRAVER CO.**

P. O. Box 1184 Houston, Texas

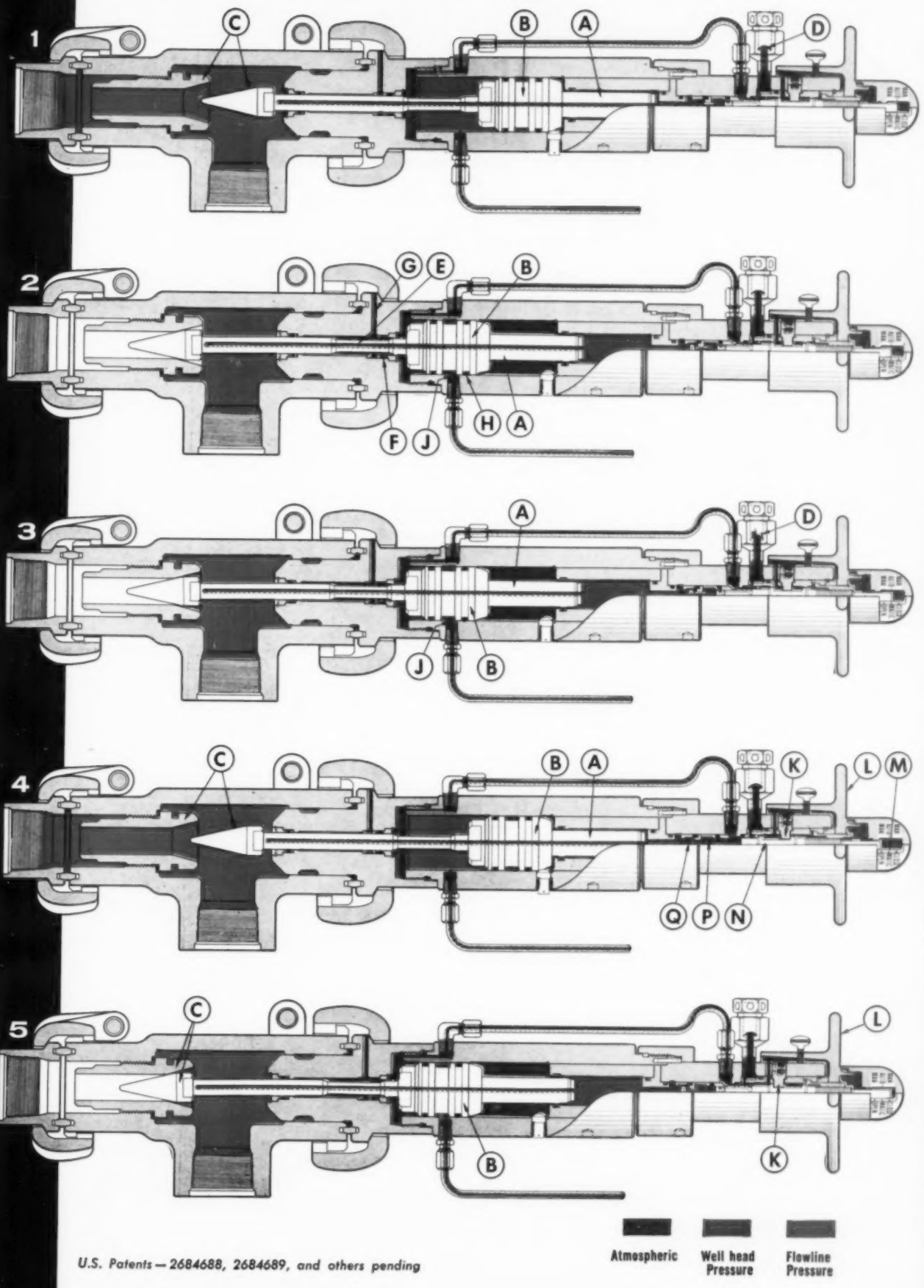
(1) — Valve is set for automatic operation and is in the open or flowing position. The size of the small or high pressure piston (A) has been chosen so that the flowline pressure (green) acting on the large piston (B) will exert a force slightly higher than that caused by the well head pressure (red) acting on the small piston. Thus, the valve (C) is held open. The strength of the rupture disc (D) is slightly higher than the flowline pressure and is holding the flowline pressure in the valve.

(2) — Valve is still set for automatic operation, but as a result of a reduction in flowline pressure (green), the valve has closed. This would result from, for example, a line break. The reduction of flowline pressure has lessened the force exerted on the large piston (B) until it has been over-balanced by the force of the well head pressure (red) on the small piston (A), thus closing the valve. As the piston moves toward the closed position, note that the reduced diameter portion (E) of the stem moves past an "O" ring seal (F). As a result the space under the large piston (B) which contained flowline pressure is now bled to atmosphere (blue) through port (G). This assures the valve closing fully as it prevents pressure being trapped under the piston. Note, also, that the first large "O" ring seal (H) on the large piston (B) has moved down past the inlet (J) of the flowline pressure, thus shutting off the source of flowline pressure to the valve. This action prevents the reopening of the valve in the event the flowline pressure should build up again. This is a safety feature, making it necessary for the operator to go to the valve to reset it after it has operated.

(3) — Valve is still set for automatic operation but in this case it is closed due to a build-up of flowline pressure above that pressure for which the rupture disc (D) was selected. The rupture disc has burst due to overpressure and this has bled to atmosphere the area under the large piston (B). The high pressure acting on the small piston (A) then closed the valve in the same manner as in (2). Note that once again the flowline pressure inlet (J) is closed off by the large piston (B) so that the rupture disc (D) ceases to bleed-off pressure as soon as the valve closes.

(4) — Valve is shown being opened manually with the pilot valve which is built into the top of the main valve. Before this is done the operator must take steps to correct the conditions which caused the closing. For example, if the rupture disc has burst, it must be replaced. In this step the pilot valve has been placed in the manual open position by rotating the handwheel (L) counterclockwise until it hits the stop (K). The indicator (M) at the top indicates the position of the main valve (C) as controlled by the pilot valve. The pilot valve stem has moved down to unseat the small "O" ring seal (P) at its lower end and the small check valve (Q) has been opened by the end of the pilot valve stem (N). This allows the well head pressure to be channeled back to the underside of the large piston (B) which overpowers the force of this same pressure on the smaller piston (A), thus moving the pistons to the open position.

(5) — In this view the pilot valve is set for manual closing of the valve (C). This is accomplished by rotating the handwheel (L) clockwise until it hits the stop (K). This relieves the pressure under the large piston (B) and the valve closes in the same manner as if the rupture disc had burst. In this position there is no flow of gas after the valve closes and the valve may be left in the manual close setting position for as long as desired without ill effects.



U.S. Patents — 2684688, 2684689, and others pending

Results of . . .

Waterflooding in Eastern Kansas

Here in detail are the well-tabulated results of seven Eastern Kansas waterflood projects representing a total water injection of 19,000,000 bbl

R. F. Lollar,
General Manager
Maracaibo Oil Exploration Corporation, Ottawa, Kansas

FOR THE PAST SEVERAL YEARS, the Maracaibo Oil Exploration Corporation has operated water flood properties in Eastern Kansas. All properties are in the Squirrel sand reservoir at about 600–700 ft depth and are located in a three-county area. Generally, the circumstances throughout all the operations, such as pumping conditions, spacings, quality of water, water treatment, completion methods, and water pressures are sufficiently similar and cause no distortion of the end results in either the individual studies or any associated averages.

The entire purpose of this presentation is merely to demonstrate by individual entities, by averages, and by total of all leases, the beneficial results in oil production that were obtained from injected waters, the volumes of water that were produced with the oil, and the timing involved in all instances. Reservoir characteristics as related to individual studies will aid the interested reader in making selected determinations of his own choosing. Obviously, no end of curves are available from this study, but for practical purposes the curves presented are limited to the total of all seven properties.

There was in one instance an interruption of several months in development, which naturally would cause some slight variance in the figures as they relate to the other studies, but on all other properties the progress of development was normally consistent. While waterflooding activities of all properties were initiated at different times, the data is presented in terms of age of waterflood, and the totals of all properties therefore would have been the actual figures had all properties been started simultaneously.

One property under study did not respond satisfactorily to waterflooding. Other properties, especially where air had not been previously introduced, responded beyond our original expectations. Here again, however, there is thought to be no great amount of distortion of the average values because in the instances above mentioned the acreage involved as associated to the entire spread is very small.

Economics and engineering serve no purpose of this presentation and are intentionally omitted.

All properties are now of sufficient age so that the final recoveries of oil to economic limits are definitely established, and projected figures of water and oil were necessary in only a few instances. While the future may reveal some error in these hypothetical figures, it is presently believed that such could only assume insignificant pro-

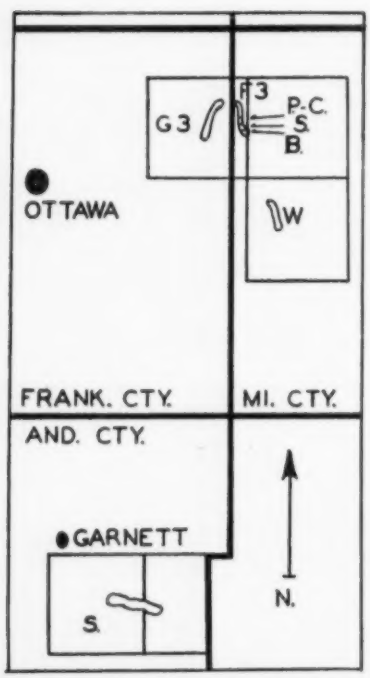


FIG. 1. Location of seven waterflooded properties studied in this report are shown in this generalized view.

TABLE 1. Physical Characteristics of Leases in Flood (Bbl in thousands).

	Leases							
Property	G3	W	F3	P-C	S	B	St	Totals
Developed acres	196	86	138	31	20	8	80	559
Avg sand thickness (ft)	18	29	18	18	18	15	13	—
Acre-feet	3528	2494	2484	558	360	120	1040	10,584
No. core analyses	9	6	18	19	11	5	10	78
Gravity of oil (API)	31	30	28	27	28	25	36	—
Avg oil saturation	41.0%	43.0%	41.0%	41.3%	38.1%	38.0%	38.0%	—
Avg water saturation	39.0%	39.8%	39.0%	39.8%	41.6%	44.5%	33.3%	—
Avg porosity	20.1%	20.7%	21.0%	22.2%	20.9%	21.2%	18.0%	—
Total pore space (bbl)	5600	4000	4041	960	583	197	1500	16,881
Total oil content (bbl)	2296	1720	1656	396	222	75	560	6,925
Total water content (bbl)	2184	1592	1576	382	242	88	500	6,564
Total void space (bbl)	1120	688	809	182	119	34	440	3,392
7-years oil recovery (bbl)	757	541	572	205	126	17	424	2,642
Final anticipated recovery (bbl)	954	550	670	210	126	17	450	2,977
Final recovery (bbl/acre)	4867	6395	4855	6774	6300	2125	5625	5326

portions and would have little or no bearing on the final conclusions.

Reservoir Analyses

As stated, all floods are within the Squirrel sand reservoir. In all cases the floods are of the shoe-string type, being on the average perhaps 500–600 ft wide and, if put end to end, about eight miles long. In spite of the rather poor possibilities of water confinement on this type of a reservoir, there has been little or no demonstration of other than normal water escapage. In Franklin and Miami Counties, the sand visually appears as very dark brown, almost black, in color and is frequently found as a solid body without shale separations. In Anderson County, however, the sand is given to much shale separation and is lighter in color, resembling in many ways the Bradford 3rd Sand, and responds similarly. Specific gravities of crude oil vary from 26 to 36 deg API. Many core analyses are available on all properties from which averages were established and are presented in Table 1.

In Table 1, the reservoir characteristics and some factual data are illustrated. Assumptions were made in some instances where insufficient cores were available, and the possibility of

The Author

R. F. Lollar is general manager of the Eastern Kansas Division of Maracaibo Oil Exploration Corporation, with whom he has been employed since 1954. After attending Purdue University, he joined Penn Valley Crude Oil Corporation in 1935, and in 1937 was named vice president and member of the board of directors of the company. In 1940, he became president of the company and member of the board, in which capacity he served until joining Brundred Oil Corporation in 1952 as general manager. In 1954, the Eastern Kansas properties of Brundred were purchased by Maracaibo Oil Exploration Corporation and he became general manager of these properties for Maracaibo. He has been employed in waterflooding in some capacity since 1935, in field of Pennsylvania, Oklahoma, New York, and Eastern Kansas.

TABLE 2. Water Introduced (Thousands of Bbl per quarter).

	Leases							Totals	
Quarter	G3	W	F3	P-C	S	B	St	Total	Cumulative
1	20.8	111.1	28.6	2.8	23.5	4.8	12.5	204.1	204.1
2	176.4	124.7	51.3	23.3	51.6	17.6	15.7	460.6	664.7
3	174.5	172.0	44.5	52.0	80.6	20.0	33.8	577.4	1,242.1
4	177.4	154.9	42.1	66.7	92.8	19.3	80.8	634.0	1,876.1
1	170.1	146.8	74.1	69.7	80.2	18.4	151.2	710.5	2,586.6
2	149.9	223.0	72.0	67.1	76.1	19.3	157.2	764.6	3,351.2
3	186.5	213.6	82.8	58.7	69.0	19.6	144.2	774.4	4,125.6
4	240.6	222.7	100.4	50.8	71.1	21.7	135.8	843.1	4,968.7
1	219.0	211.7	121.7	49.1	70.0	23.6	115.8	810.9	5,779.6
2	224.9	191.2	123.2	50.4	66.9	24.1	113.1	793.8	6,573.4
3	212.2	165.6	119.6	49.3	66.5	21.3	124.1	758.6	7,332.0
4	204.0	165.7	127.4	58.7	60.3	20.0	111.4	747.5	8,079.5
1	200.5	147.7	127.5	58.3	60.0	20.0	108.4	722.4	8,801.9
2	196.9	148.8	102.1	55.2	60.0	20.0	109.0	692.0	9,493.9
3	201.3	135.5	103.2	56.4	60.0	20.0	90.7	667.1	10,161.0
4	201.8	172.5	107.8	59.2	60.0	20.0	85.2	706.5	10,867.5
1	183.3	169.2	127.3	56.0	55.0	20.0	81.7	692.5	11,560.0
2	190.5	145.9	129.4	54.0	55.0	20.0	99.6	694.4	12,254.4
3	195.9	162.7	108.9	52.0	55.0	20.0	92.2	686.7	12,941.1
4	187.0	151.4	117.4	50.0	55.0	20.0	88.2	669.0	13,610.1
1	188.7	143.2	131.0	48.0	50.0	20.0	108.1	689.0	14,299.1
2	218.7	123.6	115.9	48.0	50.0	20.0	111.9	688.1	14,987.2
3	222.4	111.5	121.7	48.0	50.0	20.0	94.1	667.7	15,654.9
4	232.6	122.6	114.1	48.0	50.0	20.0	90.0	677.3	16,332.2
1	223.3	120.0	120.3	48.0	50.0	20.0	90.0	671.6	17,003.8
2	222.4	120.0	139.6	48.0	50.0	20.0	85.0	685.0	17,688.8
3	228.8	120.0	135.0	48.0	50.0	20.0	85.0	686.8	18,375.6
4	233.8	120.0	135.0	48.0	50.0	20.0	85.0	691.8	19,067.4
Total	5484.2	4317.6	2923.9	1423.7	1668.6	549.7	2699.7		

TABLE 3. Oil Production (Thousands of bbl per quarter).

	Leases							Totals	
Quarter	G3	W	F3	P-C	S	B	St	Total	Cumulative
1	1.1	1.7	2.8	0.5	0.4	1.3	1.0	8.8	8.8
2	3.2	17.3	4.8	1.6	5.9	1.0	2.5	36.3	45.1
3	3.1	36.6	8.5	11.9	11.8	1.2	2.5	75.6	120.7
4	4.2	41.7	9.4	17.6	12.2	0.8	6.5	92.4	213.1
1	20.9	39.4	12.5	16.8	10.7	0.7	20.4	121.4	334.5
2	22.8	41.4	16.0	15.7	9.0	0.8	41.9	147.6	482.1
3	39.5	40.3	24.4	14.3	8.1	0.7	38.0	165.3	647.4
4	41.1	36.0	26.6	13.0	7.2	0.7	32.8	157.4	804.8
1	41.9	33.4	28.3	11.6	6.7	0.7	28.8	151.4	956.2
2	43.2	31.6	26.2	11.1	6.0	0.7	25.2	144.0	1,100.2
3	42.2	27.3	26.5	10.5	5.4	0.6	22.8	135.3	1,235.5
4	37.4	24.2	31.7	9.7	5.0	0.6	20.5	129.1	1,364.6
1	40.0	20.2	33.1	8.1	4.6	0.6	17.6	124.2	1,488.8
2	36.7	18.4	29.9	7.4	4.2	0.6	16.4	113.6	1,602.4
3	36.8	16.3	29.2	6.5	3.8	0.6	14.2	107.4	1,709.8
4	34.7	13.7	29.5	6.3	3.3	0.6	13.4	101.5	1,811.3
1	30.9	12.8	28.6	5.9	3.0	0.5	12.2	93.9	1,905.2
2	30.7	11.1	26.5	5.3	2.7	0.5	11.8	88.6	1,993.8
3	29.6	10.4	23.8	4.8	2.4	0.5	11.4	82.9	2,076.7
4	26.5	9.5	21.7	4.1	2.2	0.5	10.7	75.2	2,151.9
1	26.0	8.0	20.6	3.6	2.0	0.4	10.9	71.5	2,223.4
2	26.8	8.2	19.2	3.3	1.7	0.4	10.4	70.0	2,293.4
3	24.7	7.8	17.8	3.0	1.5	0.4	10.0	65.2	2,358.6
4	24.1	7.0	16.2	2.8	1.4	0.4	9.6	61.5	2,420.1
1	23.9	7.0	15.6	2.6	1.3	0.4	9.0	59.8	2,479.9
2	22.6	6.8	14.7	2.4	1.2	0.4	8.1	56.2	2,536.1
3	22.0	6.6	14.0	2.2	1.1	0.4	7.9	54.2	2,590.3
4	20.1	6.4	13.8	2.0	1.0	0.4	7.8	51.5	2,641.8
Total	756.7	541.1	571.9	204.6	125.8	17.4	424.3		

errors is recognized. Sand thicknesses and other calculated data were either computed from weighted averages of individual oil well identity study or from isopachous maps.

On some properties one will observe that we will finally have produced a small percentage of the original oil content. "B" Lease is a case in point where waterflooding was not satisfactorily successful. In a few cases the percentage rate was excellent. Lease "P-C" is such a situation. On this operation it might be worthy to mention that the use of fully automatic oil wells was employed and, in addition, this lease was the area selected for the testing of a then comparatively new surfactant. In all situations the total oil recovery in its relation to time is governed largely by the economics of the individual entity.

Water Injected

Tabulation of introduced water is submitted in thousands of barrels per quarter year of waterflood age in Table 2. A breakdown of all properties in this and other tabulations is afforded for persons interested in calculating curves and/or other data from individual studies. The total peak injection rate was established almost two years after flood inception. This resulted from earlier lower pressures and the policy of the operator to approach that point without undue haste. Five years after that peak was established, the rate, under generally constant pressures, had declined only to 82 percent of the original figure, indicating little or no plugging action from introduced water. The total water injected of 19,067,400 bbl is equivalent to 34,000 bbl per acre or 1,801 bbl per acre ft. Some projection of figures was necessary on a few leases not yet seven years old.

Tabulations of fluid production (both oil and water) are shown in Tables 3 and 4. Again some projections were necessary, but volumetrically as compared to the whole they are inconsequential. Total oil produced of 2,641,800 bbl is equivalent to 4725 bbl acre or 250 bbl acre ft; however, the ultimate total expectation will approximate 281 bbl per acre-ft. Total fluids produced of 13,454,000 bbl was 5,613,000 bbl less than total water introduced, or 2.2 million bbl over and above calculated reservoir void space. At study's end, the total fluids then being produced were 92 percent of waters then being injected.

Individual studies will reveal in many instances the unusual increase of produced water at a time when the calculated void was filled. The total calculated voids of 3.4 million bbl were filled

TABLE 4. Water Produced (Thousands of bbl per quarter).

	Leases							Totals	
Quarter	G3	W	F3	P-C	S	B	St	Total	Cumulative
1	0.0	0.0	1.6	0.0	0.0	1.9	0.0	3.5	3.5
2	13.0	13.7	2.8	2.2	6.9	6.1	0.0	44.7	48.2
3	24.0	23.0	3.3	15.2	20.1	7.4	4.9	97.9	146.1
4	28.0	44.3	3.5	30.3	29.1	8.4	9.5	153.1	299.2
1	31.5	32.5	12.6	34.6	31.9	8.2	23.8	175.1	474.3
2	44.5	45.9	10.6	37.0	39.8	8.8	42.7	229.3	703.6
3	68.0	68.6	11.9	32.8	36.8	10.8	58.4	287.3	990.9
4	98.1	74.0	18.3	32.9	37.9	11.2	65.1	337.5	1,328.4
1	93.1	76.0	20.5	28.9	43.0	12.4	63.2	337.1	1,665.5
2	120.0	74.9	37.2	30.5	52.0	12.7	64.7	392.0	2,057.5
3	101.2	79.0	50.1	32.8	57.7	12.3	70.1	403.2	2,460.7
4	106.1	79.3	58.1	39.5	50.3	12.0	70.3	415.6	2,876.3
1	111.8	70.8	57.0	41.3	50.0	12.0	72.3	415.2	3,291.5
2	108.1	72.0	55.9	35.9	50.0	12.0	75.6	409.5	3,701.0
3	132.8	76.8	49.6	46.0	50.0	12.0	73.9	441.1	4,142.1
4	135.5	84.6	46.6	40.8	50.0	12.0	64.2	433.7	4,575.8
1	134.9	91.2	49.2	40.0	50.0	14.0	61.0	440.3	5,016.1
2	138.8	80.9	69.0	40.0	50.0	14.0	71.6	464.3	5,480.4
3	127.7	90.9	48.2	40.0	50.0	14.0	74.6	445.4	5,925.8
4	130.3	89.3	52.0	40.0	50.0	14.0	75.9	451.5	6,377.3
1	105.7	90.1	58.6	40.0	50.0	15.0	75.0	434.4	6,811.7
2	161.6	82.7	100.0	40.0	50.0	15.0	104.8	554.1	7,365.8
3	162.3	92.3	119.1	40.0	50.0	15.0	80.0	558.7	7,924.5
4	169.6	88.3	133.8	40.0	50.0	15.0	80.0	576.7	8,501.2
1	169.5	85.0	131.8	40.0	50.0	15.0	75.0	566.3	9,067.5
2	176.1	85.0	132.6	40.0	50.0	15.0	75.0	573.7	9,641.2
3	186.3	85.0	132.0	40.0	50.0	15.0	75.0	583.3	10,224.5
4	190.9	85.0	132.0	40.0	50.0	15.0	75.0	587.9	10,812.4
Total	3069.4	1961.1	1597.9	960.7	1205.5	336.2	1681.6		

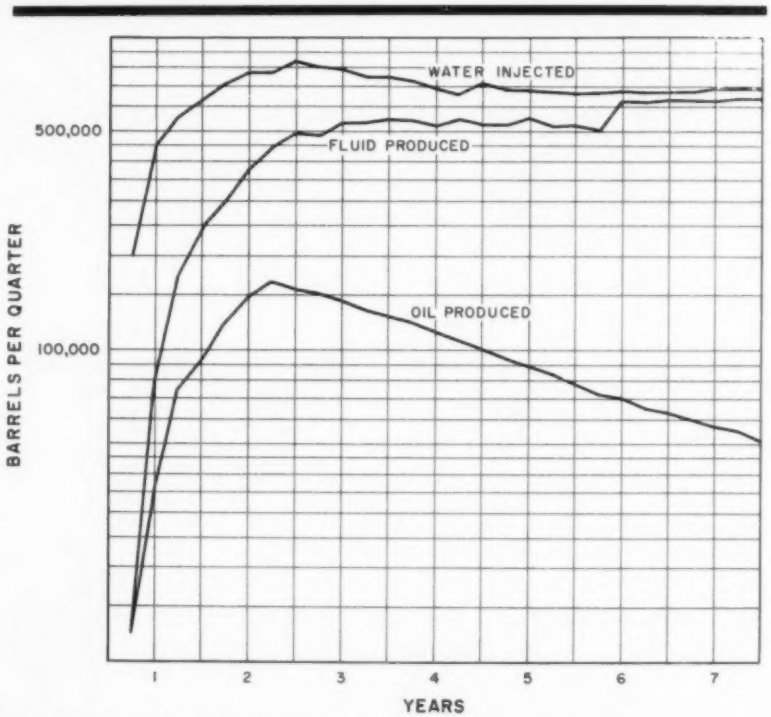
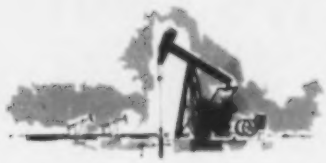


FIG. 2. Curves of water injected, total fluid produced, and oil produced on a quarterly basis. The oil production curve is a steady decline and indicates no tendency to change its rate of declination in the 7-year period under consideration.

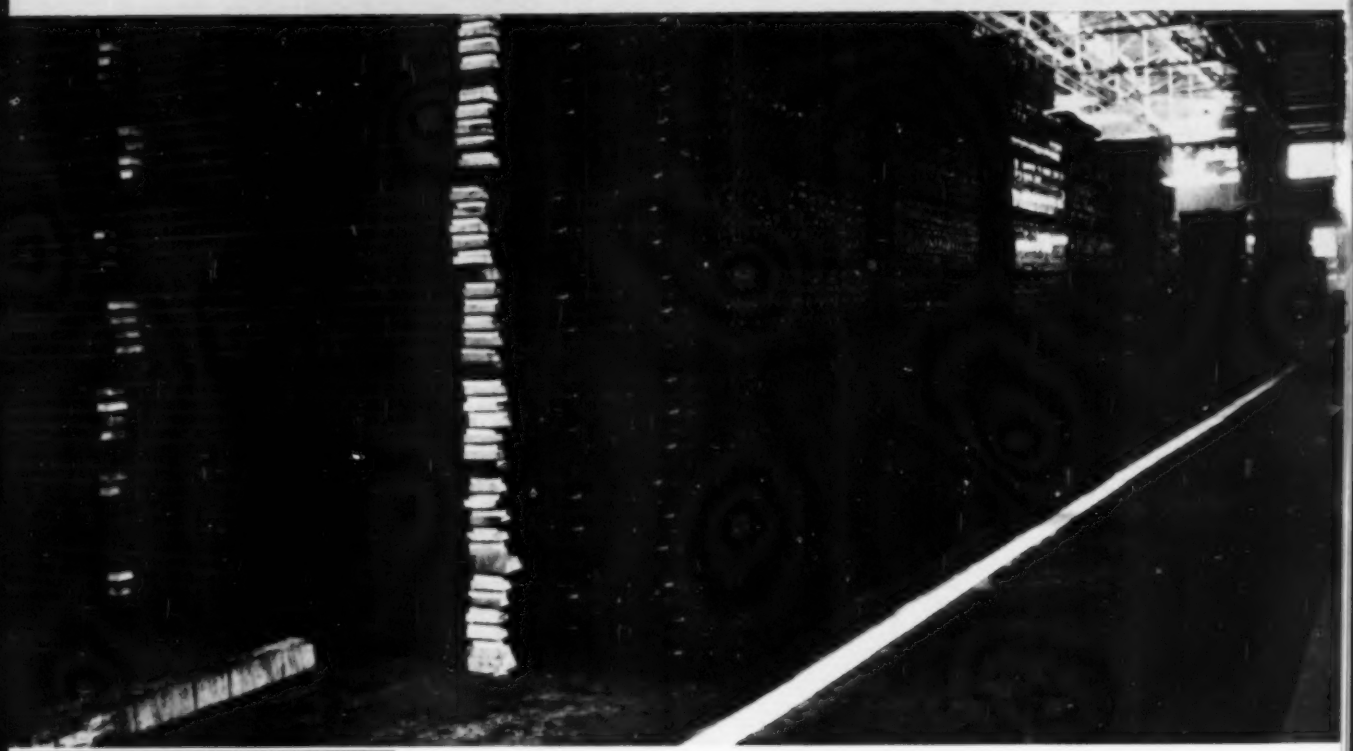


PICK ANY WELL YOU'LL PUMP IT BETTER WHEN YOU Specify

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide

PICK CONTINENTAL SUCKER RODS



Let your C-E man explain the many metallurgical advantages of Continental sucker rods. He knows how the chemical properties of the rods react to the specific fluids being pumped in your area. He can show you how the use of a certain Continental rod grade as well as rod string design, subsurface pump design and well counterbalancing will greatly affect the life of your sucker rod string. This first hand information is invaluable. So, specify a Continental sucker rod . . the *better* rod, in four grades to meet all well conditions.

Continental-Emsco's *complete supply system* provides local sucker rod stocks near your lease . . backed up by large, complete stocks at C-E's modern Garland, Texas sucker rod plant.

CONTINENTAL SUCKER ROD COUPLINGS

Each Continental coupling is 100% inspected before leaving the plant to insure unexcelled performance. Exteriors are hardened against wear while interiors remain ductile to absorb shock loads.

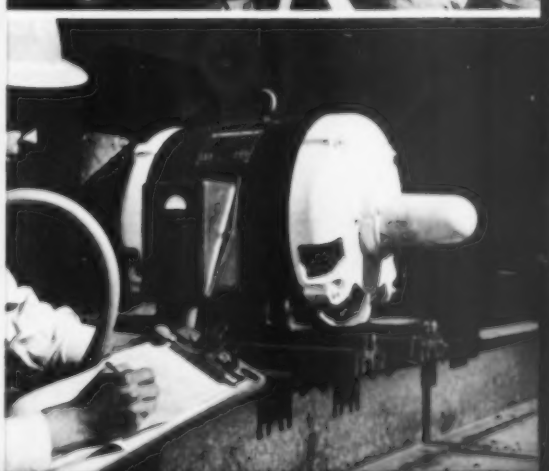
AND D+B SUBSURFACE PUMPS

There's a combination to pump every one of your wells

D+B subsurface pumps are made to API specifications. This means a great savings for you when special pump types are needed to produce large volumes, pump two or three zones, pump gaseous or corrosive fluids. Such D+B pumps are assembled with standard API parts from your inventory, plus only a few special parts. Get acquainted with the flexible D+B subsurface pump line of 37 types with over 700 variations. See how the competitive priced D+B pumps

PICK YOUR LOWEST COST POWER

Where does your profit advantage lie.. pumping with gas or electricity? Get the advice of your C-E man. He sells the only two unit pumper prime movers *originally* designed for oil field pumping: C-E Engines.. always in a class by themselves for superior performance in producing fields of the world; and C-E Green Triangle Electric Motors.. the *common sense* motor that takes the guesswork out of well counterbalancing for lowest possible electric cost and less wear on all pumping equipment. Your C-E man is never biased.. *both motor and engine* are of C-E design.



PICK CONTINENTAL SUCKER RODS

AND D+B SUBSURFACE PUMPS

There's a combination to pump every one of your wells

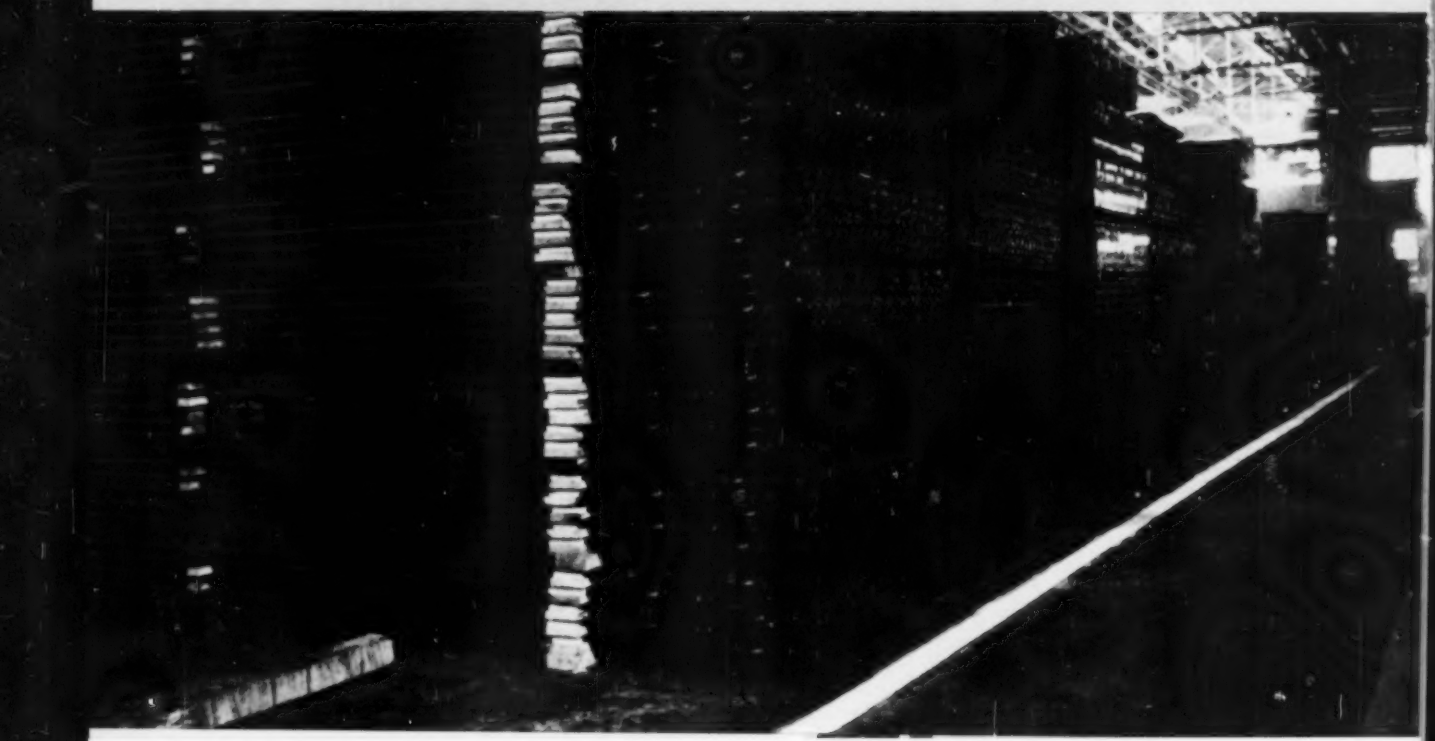
D+B subsurface pumps are made to API specifications. This means a great savings for you when special pump types are needed to produce large volumes, pump two or three zones, pump gaseous or corrosive fluids. Such D+B pumps are assembled with standard API parts from your inventory, plus only a few special parts. Get acquainted with the flexible D+B subsurface pump line of 37 types with over 700 variations. See how the competitive priced D+B pumps

PICK A NEW CONTINENTAL-EMSCO UNIT PUMPER . . DESIGNED TO API's SUGGESTED STANDARDS

New and completely designed to API specifications, C-E unit pumpers give you (1) improved torque factor to cut gas and electricity costs and (2) more flexible well load rating to meet current and changing conditions. This new design, combined with C-E field proven features, meets rigid performance standards through exhaustive scientific tests.

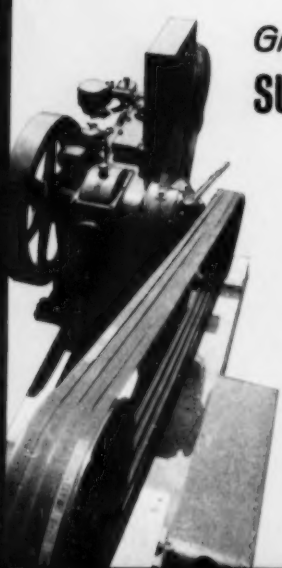
BE SURE . . SPECIFY C-E UNIT PUMPERS *Engineered even better..not just built*

PICK CONTINENTAL SUCKER RODS



DON'T PICK JUST ANY ACCESSORY

standardize on the finest from C-E



Green Triangle

SUPER V-BELTS

These belts are sold in matched sets to assure uniformity in length, diameter, thickness, material and freshness. Each set *pulls as a unit* for maximum power transmission and evenness of wear for months of operating life. New Green Triangle Super V-Belts deliver 40% more horsepower . . *no extra cost.*

Continental API

POLISHED RODS

Five Continental polished rods are manufactured, ranging from HEATREAT, a high-grade medium carbon piston steel to MONEL for extreme corrosive conditions. Tensile strength ranges from 90,000 to 110,000 psi. This wide choice makes it easy to meet your pumping problems with Continental polished rods . . . the finest available.

Kwik-Grip

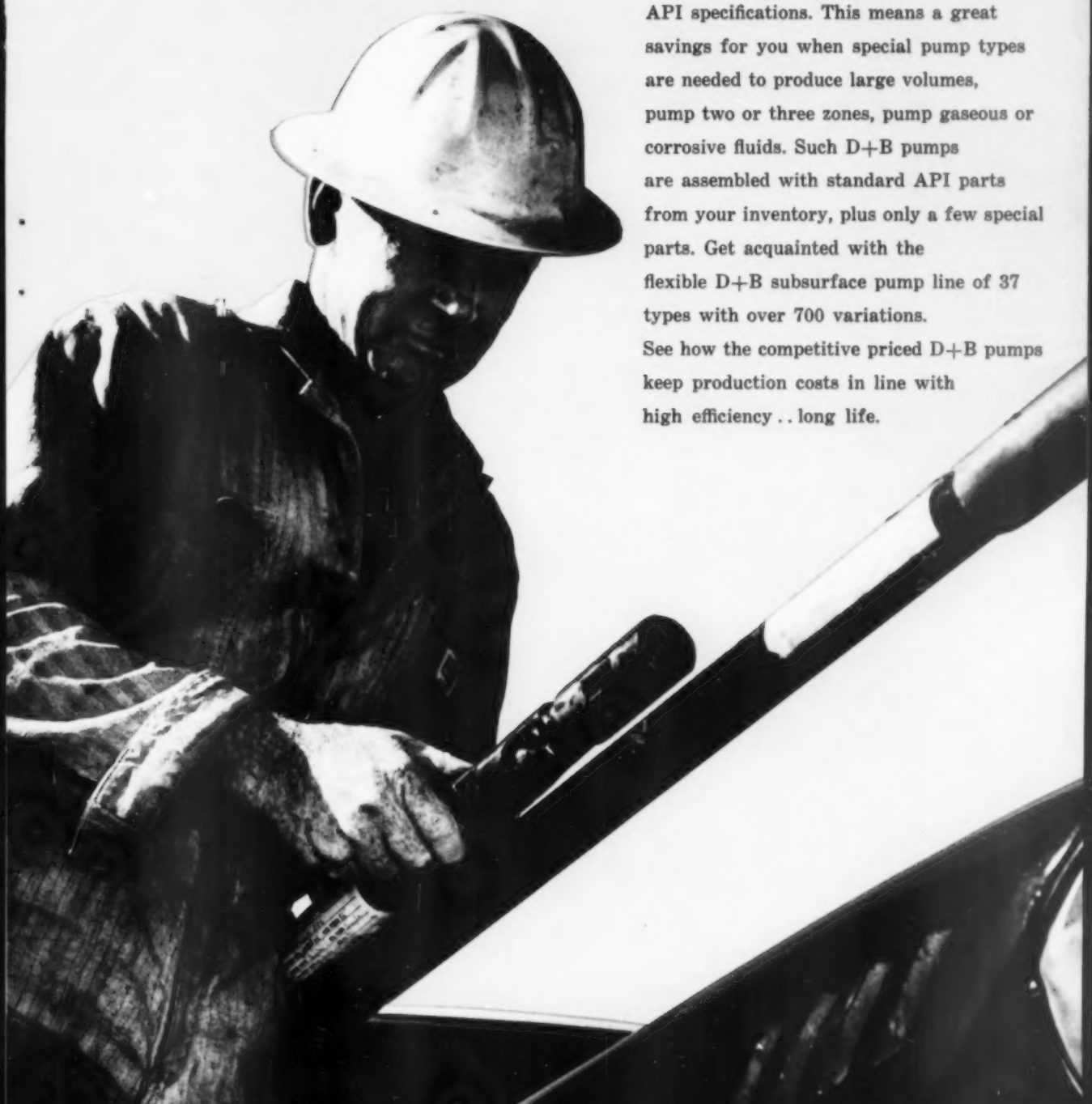
CLAMPS

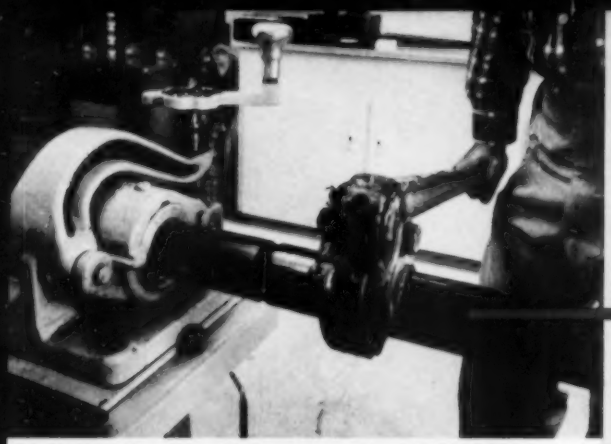
Available in two or one-bolt units, Kwik-Grip clamps are designed for fast, one-man installation. Simple tee-head bolt construction cuts installation time and eliminates "knuckle-busting."

AND D+B SUBSURFACE PUMPS

There's a combination to pump every one of your wells

D+B subsurface pumps are made to API specifications. This means a great savings for you when special pump types are needed to produce large volumes, pump two or three zones, pump gaseous or corrosive fluids. Such D+B pumps are assembled with standard API parts from your inventory, plus only a few special parts. Get acquainted with the flexible D+B subsurface pump line of 37 types with over 700 variations. See how the competitive priced D+B pumps keep production costs in line with high efficiency . . long life.





IT TAKES SPECIAL TOOLS SPECIAL TRAINING TO KEEP YOUR SUBSURFACE PUMPS AT TOP EFFICIENCY

Especially equipped D+B subsurface pump shops like these are located in producing areas everywhere. Here you find that only factory trained . . field experienced . . men work on your pumps. An assurance that your pumps will stay in the well longer with fewer pulling jobs . . less production lost.

For Service that Sings . .
Equipment that Hums . . Go . .

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide

P924

CONTINENTAL-EMSCO COMPANY • A Division of The Youngstown Sheet and Tube Company • General Offices: Dallas, Texas
Export Division: 30 Rockefeller Plaza, New York, N. Y. • Continental-Emsco Company Limited • General Offices: Calgary, Alberta, Canada
Continental-Emsco Company C. A., Caracas, Venezuela • Plants: Houston and Garland, Texas; St. Albans, Herts., England
Representatives in All Principal Oil Fields of the World

Litho in U.S.A.

HOW BIT LUBE AND MAGCOBAR ENGINEERING CUT DRILLING COSTS

In a West Texas Well, Magcobar Engineers put a film here *to make* *net savings of $4.87 per foot*

	NO. BITS	BIT SIZE	INTERVAL	ROTATING HOURS	WEIGHT ON BIT	RPM
BIT LUBE-WATER	28	7⅞"	4919-7272	185	70-90,000	60-80
WATER	40	7⅞"	4936-7278	379	45-60,000	55-60

You are always sure of getting every cost-cutting advantage with Magcobar. Here's why: The Magcobar Mud Engineer combines a thorough knowledge of drilling fluid chemistry with experience in your drilling area. This background—plus the top mud lab in the country—gives new dimension to the finest and most complete line of drilling mud products. What does this mean to you? The highest level of product performance to cut your drilling costs.

Here's proof of actual savings using Bit Lube (E. P. Additive for Mud). The table shows a drilling cost comparison in the Brownfield, Texas, area. The Bit Lube well was drilled for $4.87 per foot less than the offset well. Total savings in bits, trips, and drilling was $13,420. Bit Lube and emulsifiers cost $1,940; a net saving of $11,480!

Bit Lube forms a tough protective film to reduce friction and to increase bit bearing life under extreme pressure conditions. It works best with high weight on the bit and fast rotary speed. Bit Lube and Magcobar engineering may be the answer to your bearing failures.

Bit Lube is only one of Magcobar's many answers to the problem of high drilling cost, a problem that demands the right answers. You'll find that the right products *used right* by Magcobar can cut costs on your next well, too.

MAGNET COVE BARIUM CORPORATION
HOUSTON, TEXAS

Magcobar
Complete
DRILLING MUD SERVICE

Another Well Done *with Magcobar Technology !*

during the second quarter of the second year, at a time when produced water was increasing substantially and just 8 months prior to a stabilizing production period. In the middle of the sixth year the water production increased substantially after a period of 3 years of consistent rate. At this time 15 million bbl had then been injected into the reservoir, which is 90 percent of the calculated reservoir capacity. The total final ratio of water produced to oil produced was 4.1 to 1.0, which at the end of the 7-year period was then 11.4 to 1.0.

The schedule in Table 5 results from consideration of the reservoir fill-up and its beneficial results in terms of percentage. For instance, at the year's end:

1. Indicates the cumulative water injection in terms of percent of the total calculated reservoir capacity.
2. Indicates the percent of the total oil to be produced in 7 years that was produced up to that time.

TABLE 5. Synopsis of Flood Results.

End of Year	(1)	(2)	(3)	(4)
1	11.1	8.1	11.3	14.5
2	29.4	30.5	16.1	18.6
3	47.8	51.6	16.8	17.3
4	64.3	68.5	16.7	14.3
5	80.6	81.4	15.8	11.2
6	96.7	91.5	14.8	9.1
7	112.9	100.0	13.8	7.4

3. Indicates the percent of water injected that had cumulatively materialized in oil produced up to the time indicated.
4. Indicates the percent of water injected that was currently materializing in oil produced at that year's end.

Conclusion

It is not intended to draw any particular conclusion from this presentation, as readers will probably arrive at various conclusions should they be sufficiently interested to curve the factual data that is available from separate properties. If one does wish to go to such lengths, he will find much interesting material, but it will not necessarily be comparable to the values of total figures. It is not intended to imply that operator's results were anything other than normal, and, if indeed they are normal, it is possible that readers can make comparisons with other floods in the determination of the beneficial results of injected waters. It is intended to supply sufficient factual data herein that may be of interest or help to others so involved, and, while there are many other factors that would have to be considered in

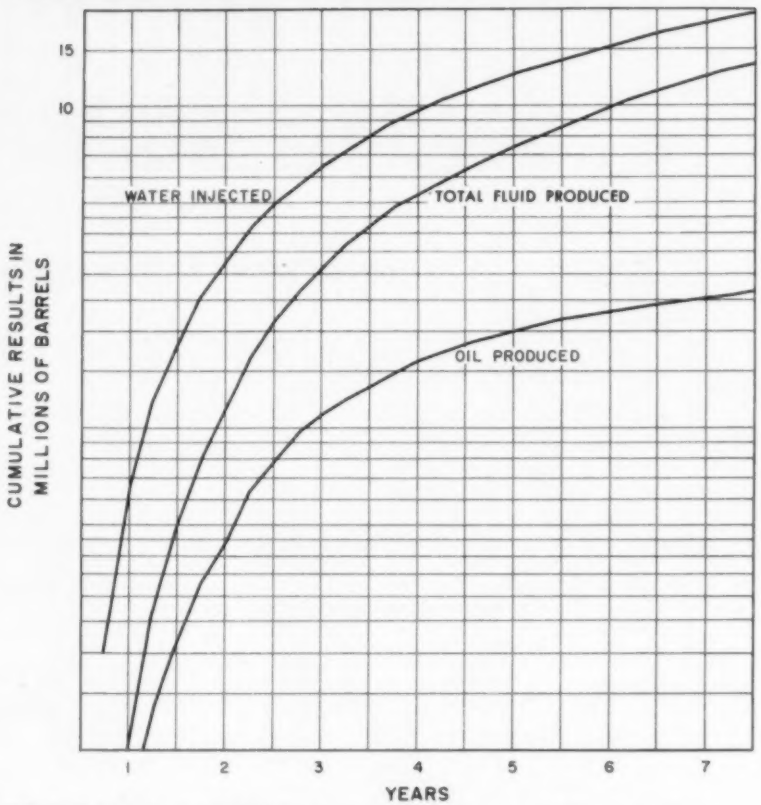


FIG. 3. Curves show cumulative results of water injection and fluids produced.

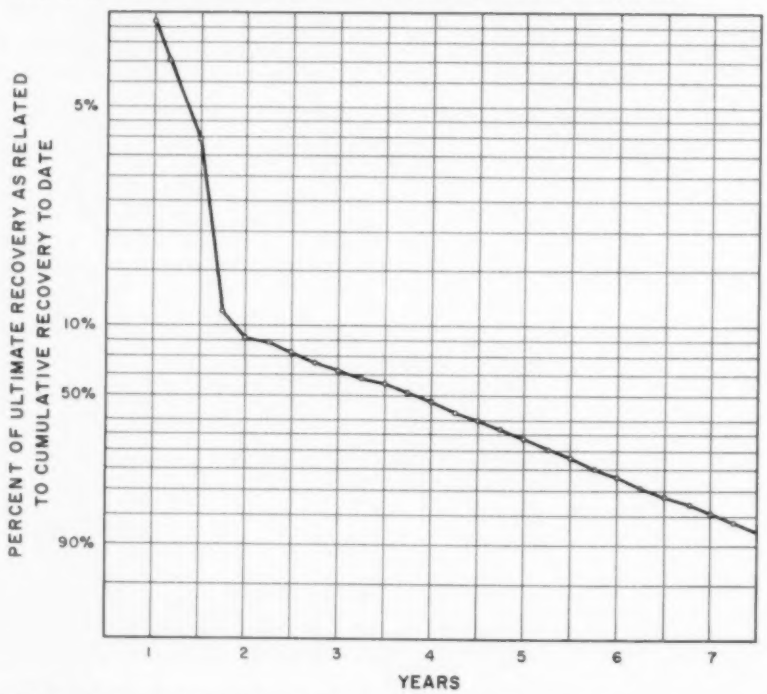


FIG. 4. On inverted log scale, the percentage of the final eventual and total oil to be produced, as related to the cumulative results at quarter's end, forms a straight line curve after 10 percent of the oil has been produced.

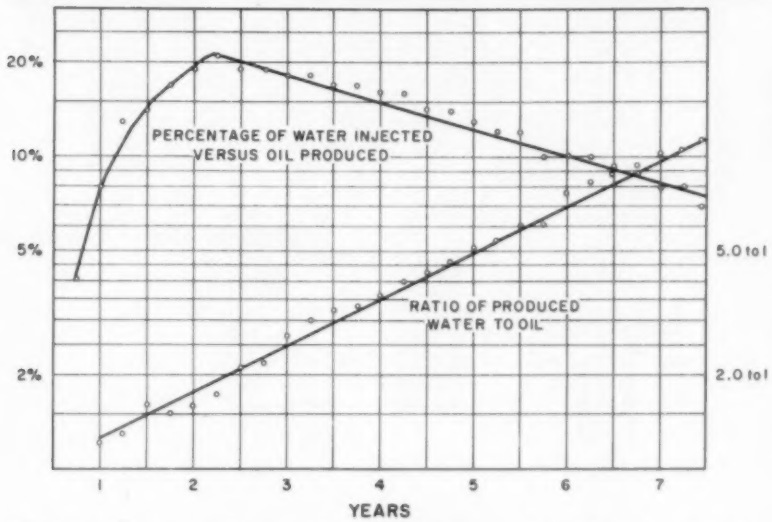


FIG. 5. Curves showing the suggested straight line curves formed by the ratio of water produced to oil produced, as well as the ratio of water injected to oil produced.

these operations, we have presented many of the pertinent facts that form a relationship between water injected versus fluids produced.

It is pointed out that a comparison was made between these curves and one of a Bradford 3rd Sand curve. The results indicated nothing other than insignificant differences, and, given similar conditions, there is every reason to believe that these same results could apply to many other sand reservoirs.

Discussion

At some point on a curve of water flood production, a peak is established. In this case, had the curve been shown on a monthly instead of quarterly basis, that peak production would have been established at a time when the void space was about three-fourths filled.

At another point on a curve of total fluids produced, a time is reached when the produced total fluids have stabilized. In this instance it was established shortly after the void space was filled.

Presented data will indicate that 1.12 pore volumes of water were injected during a period of seven years. In order to obtain this, it was necessary to inject an average of ¾-bbl per day per acre-ft of reservoir during the time stated. It is believed that the water needed to totally flood out these properties to their economic limits will approximate an average of 1.25 pore volumes.

There was a point in the later life of the flood (Fig. 2) where the produced water was substantially increased. At that time the cumulative water injected amounted to slightly under the total reservoir pore space, as 0.92 pore volumes had then been introduced.

It can be stated that produced oil automatically becomes a factor of water injected and that a relationship also exists insofar as produced water is concerned. To this end these factual data are presented in an attempt to illustrate the beneficial results of water injected in the area under consideration.

* * *

Texas Mid-Continent Oil & Gas Association Announces Speakers For 40th Annual Meeting

GOVERNOR J. HUGO ARONSON, Montana's "Galloping Swede," who is chairman of the Interstate Oil Compact Commission, and Gordon Simpson, Dallas, president of the Independent Petroleum Association of America, will address the 40th Annual Meeting of the Texas Mid-Continent Oil & Gas Association, September 14-16, in Houston.

Governor Aronson will address oil and gas industry leaders September 15 and Judge Simpson will speak the following day, Charles W. Alcorn, Houston, Association president, announced recently. Alcorn also will address the gathering September 15.

Alcorn said that general sessions would open at the Rice Hotel September 15 although various committees will meet September 14. Following committee meetings, a membership reception will be held at the Houston Club. Former presidents of the Association will be honored September 14 and the annual membership dinner and golf tournament will be held September 15.

Governor Aronson's career as an American began in 1911 when he left his wooden shoes on a dock in Sweden and came to the United States. He worked his way west to Montana where he homesteaded. He enlisted in 1917 before he was a citizen and fought in France during World War I.

On returning to Montana he again took up farming, but soon became a tool dresser in the oil fields and later turned to rig building. He developed his own method of moving oil rigs without dismantling them. He added a trucking business and became the largest rig builder in Montana.

Governor Aronson got his first taste of politics in 1934 when friends backed him as a Cut Bank city councilman. In 1938 he ran for the state legislature and became the first Republican representative from Glacier County in 18 years. In 1944 he was elected to the state senate.

In 1952 he was elected the 13th Governor of Montana. Throughout the years, Governor Aronson has been affectionately known as "The Galloping Swede," based on his method of working. He refers to himself as a "working stiff, not a politician."

Judge Gordon Simpson has headed IPAA since 1958. It is the largest organization of independent oil men in the United States. He is a former Texas Supreme Court justice and Texas legislator.

He received his law degree from the University of Texas in 1919 and was admitted to the Texas bar and the United States Supreme Court bar. He practiced in Tyler from 1919 to 1942.

Judge Simpson was a Texas Supreme Court Justice from 1945 to 1949. A veteran of both world wars, he is a holder of the Bronze Star and a colonel (ret.) in the army reserve. He was an investigator in the war crimes cases tried at Dachau, Germany, following World War II.

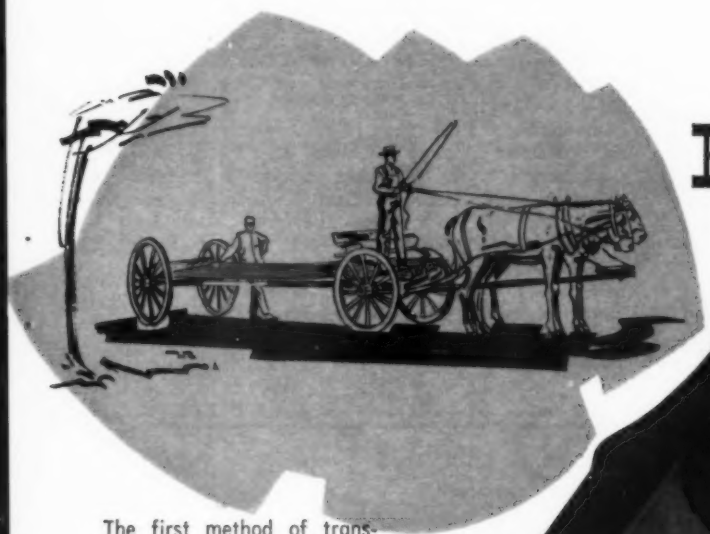
He is a former board chairman of the Texas Bar Association and served as president of the Judge Advocates Association. He is a member of the International and American Bar associations, the American Law Institute, Texas Civil Judicial Council, and a director of the Mid-Continent Oil & Gas Association.

* * *

N5 Nipple
Needle valve
FT108 Tee
T 108 Tee
CO Union
C 102 cross
5 Coupling
B Bull Plug
B4 Bull Plug
Needle valves
Tee Type "N" Choke
Reinstallation nipple
SN 11 Swedge
FC102 Cross
A-4 Adapter
T 118 Tee
B15A Adapter
FC 140 Flow Bean
3 Bull Plug
E120L
There is an O·C·T high-pressure, precision made fitting for your every need. Available in more than 700 supply stores
13 Swedge
where progress is a daily practice
O·C·T
OIL CENTER TOOL CO.
P. O. Box 3091, Houston, Texas
BT 14A Bottom hole test adapter
N Adjustable

JONES

FIRST IN 1894...



The first method of transporting Jones all-metal sucker rods left something to be desired. Not much support for those rods between the wagon axles...

FIRST TODAY...

Now, Jones Sucker Rods receive the greatest care in handling and shipping...rail or truck...so that they arrive with factory perfection. Another service you can expect from **Sucker Rod Specialists!**

...because we're Sucker Rod Specialists!

There are four JONES JOB-ENGINEERED SUCKER RODS... a type for every pumping need!

THE S. M. JONES COMPANY

Division of Buffalo Eclipse Corporation

General Office and Factory: TOLEDO, OHIO

Sales Office: Enterprise Building, TULSA, OKLAHOMA

Export Sales Representatives:

IDECO, One of the Dresser Industries, Dallas—New York

Franklin Supply Company, Export Division, Inc., New York

PRODUCTION FUNDAMENTALS

Your Personal Study Series

Development and Evaluation of . . .

Gas-Condensate Reservoirs

Part 5 *of a continuing series on gas-condensate reservoirs discusses design and application of gasoline plants*

William C. Goodson
Republic Natural Gas Company
Dallas, Texas

Gasoline Plant Considerations

After all aspects presented in previous installments have been considered, and the gathering system and field processing have been evaluated and designed, the next major consideration is the possibility of a gasoline plant installation. This is a very complex aspect and many studies, articles, and books have been written on the various phases of this problem. One that is current and that is highly recommended is a series on economics, design, equipment, and operations entitled "Modern Gasoline Plants" by Dave Vondy. The first of this series appeared in *Refining Engineer* in May 1958. That study goes into great detail on a subject that will be only briefly touched in this article.

From a managerial standpoint, four possibilities exist at the time a gas purchase contract with suitable processing agreement is negotiated:

1. Construction and operation of the gasoline plant by the producing company or companies.
2. Construction of the plant by an outside interest. (Gasoline plant specialist or the transmission company.) This plant will process the entire gas stream and give a percentage of either net or gross products to the producing company. This consideration usually necessitates a large loan (bank or insurance company) for the gasoline plant company with a payout based on net income or cash throwoff for a maximum of five years.

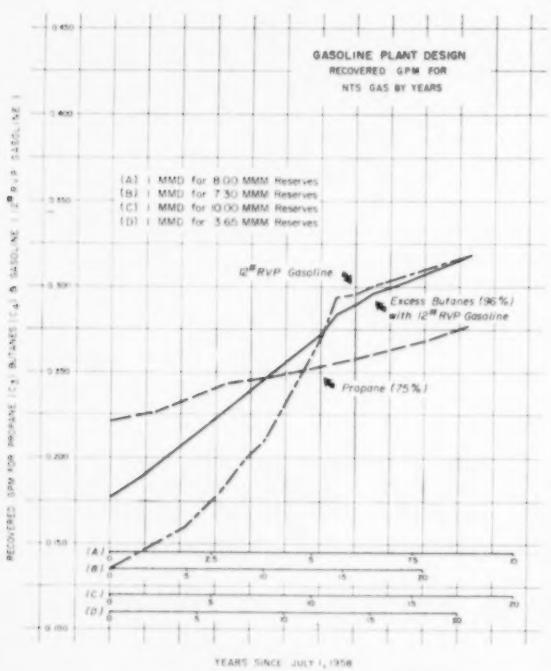

GASOLINE PLANT DESIGN
RECOVERED GPM FOR
NTS GAS BY YEARS
(A) 1 MMD for 8.00 MMM Reserves
(B) 1 MMD for 7.30 MMM Reserves
(C) 1 MMD for 10.00 MMM Reserves
(D) 1 MMD for 3.65 MMM Reserves
12# RVP Gasoline
Excess Butanes (96%) with 12# RVP Gasoline
Propane (75%)
YEARS SINCE JULY 1, 1958

FIG. 1. Actual gasoline plant study shows recovery from plant inlet stream coming from low temperature separation units.

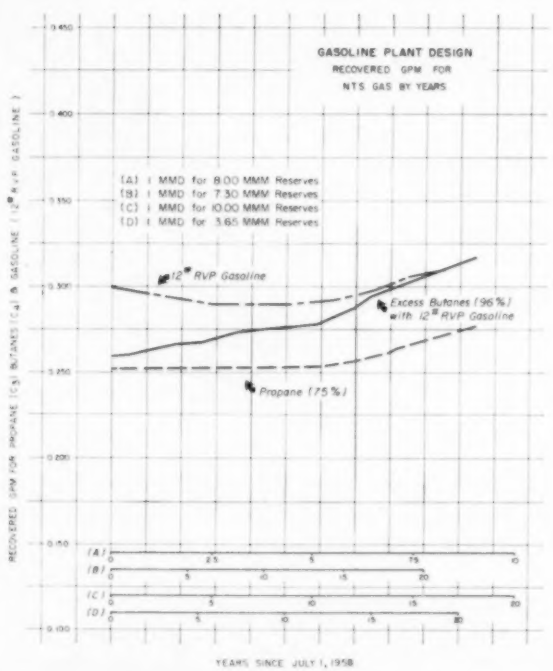

GASOLINE PLANT DESIGN
RECOVERED GPM FOR
NTS GAS BY YEARS
(A) 1 MMD for 8.00 MMM Reserves
(B) 1 MMD for 7.30 MMM Reserves
(C) 1 MMD for 10.00 MMM Reserves
(D) 1 MMD for 3.65 MMM Reserves
12# RVP Gasoline
Excess Butanes (96%) with 12# RVP Gasoline
Propane (75%)
YEARS SINCE JULY 1, 1958

FIG 2. Recovery in an actual gasoline plant with the feed stream coming from normal temperature separation units.

3. Process the gas stream in an existing gasoline plant for return of a portion of the products to the producing company.
4. In the event none of the first three can be negotiated, the producing company forfeits all rights to future claims on the recovered liquid.

Obviously each of these has advantages and disadvantages:

1. Construction of the plant by the producers will give maximum profits, but it will also tie up considerable capital that could possibly be utilized to better advantage in another venture.
2. Construction of the plant by an outside interest is a compromise that will limit the profits to the producer but free available capital for other (exploration, development, lease purchase) possibly more profitable ventures.
3. Situations where a plant exists in an active area with sufficient capacity to handle new contracts are rare. This would return a smaller profit to the producer than either Case 1 or Case 2.
4. If none of the first three proposals exist or are attractive enough to warrant serious considerations, the producer may have to forfeit his rights to the recoverable liquids remaining in the sales gas stream. This happens often to small producers in a large gas area where their possible income from a separately run plant would be almost negligible. It can and does happen to major operators in some cases where they do not desire to tie up capital in the plant construction and are unable to sell their processing rights to one of the plant owners.

For any one of the actual plant considerations, economic and feasibility studies must be made to decide which of the three approaches best fits a particular situation. The gas purchase contract will in a great measure limit the operating conditions of the plant. As the gas becomes more valuable less and less of it can be flared or used for plant fuel. At 22 cents per Mcf and above, the economics of extracting butane and propane become very marginal indeed.

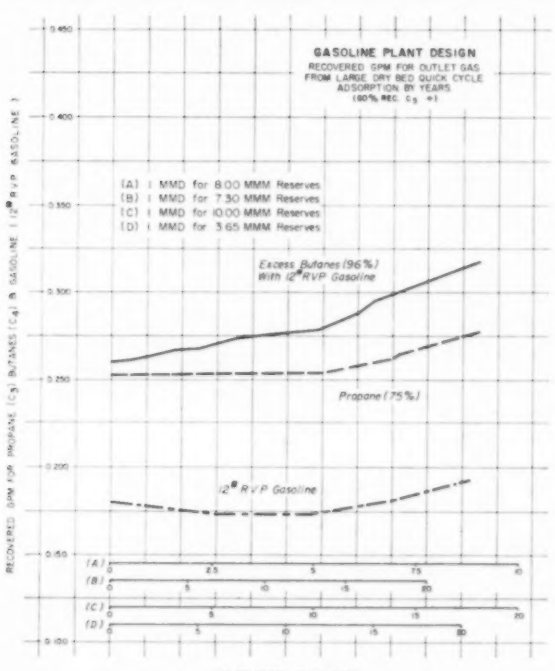

GASOLINE PLANT DESIGN
RECOVERED GPM FOR OUTLET GAS FROM LARGE DRY BED QUICK CYCLE ADSORPTION BY YEARS
(90% REC. C3 +)
(A) 1 MMD for 8.00 MMM Reserves
(B) 1 MMD for 7.30 MMM Reserves
(C) 1 MMD for 10.00 MMM Reserves
(D) 1 MMD for 3.65 MMM Reserves
Excess Butanes (96%) With 12# RVP Gasoline
Propane (75%)
12# RVP Gasoline
RECOVERED GPM FOR PROPANE (C3) BUTANES (C4) & GASOLINE (12# RVP GASOLINE)
YEARS SINCE JULY 1, 1958

FIG. 3. **Curves depict an actual gasoline plant study where the plant inlet stream is from dry bed adsorption units downstream from normal temperature separation units.**

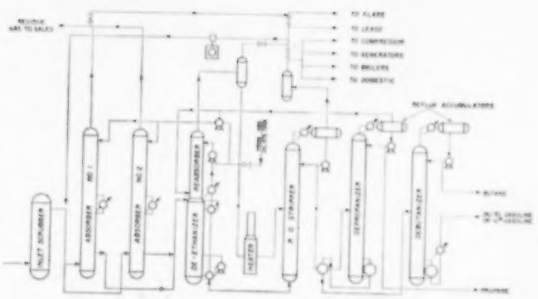


FIG. 4. **Schematic flow diagram of lean oil absorption type plant.**

The type of field gathering and processing facilities will also need to be considered in evaluating the plant feasibility. With the use of LTS glycol units and the ever-increasing use of dry bed adsorption units not too much pentanes plus material remains in the plant inlet stream. Fig. 1, 2, and 3 depict an actual gasoline plant study where the plant inlet stream was either from low temperature separation units, from normal temperature separation units, or from dry bed adsorption units downstream from normal temperature separation units. The use of the LTS units limits the gasoline plant income during the early life or payout period and this income or recovery tends to go up as the pressure in the reservoir declines. The normal temperature curve is more or less flat but does show some variation from retrograde condensation as the pressure declines. The dry bed units ahead of plants remove most of 12# RVP gasoline and leave essentially only butane and propane to be recovered in a plant.

For comparison purposes four gas purchase contracts are considered and plotted as the abscissa on these curves:

Contract	*Description*	*Life*
A	1 MM/d-8 MMM Reserves	21.9 years
B	1 MM/d-7.3 MMM Reserves	20.0 years
C	1 MM/d-10.00 MMM Reserves	27.4 years
D	1 MM/d-3.64 MMM Reserves	10.0 years

The seasonal demand for the LPG products has brought about development of underground storage cavities. The LPG is stored during the summer months when the demand is low and is sold during the winter months when the demand is high.

Selection of the route to take in the gasoline plant consideration is to a large extent determined by management policy. With a good many companies primarily in the exploration business, gasoline plant operation is not too appealing from a profit angle. In further work in this paper this will be the policy adopted and, as such, only Case 2 will be considered. Fig. 4 depicts the flow of a lean oil absorption type plant. This type of plant to handle 75 MMcf per day would cost an outside interest plant operator approximately $2,500,000.

Table 2 gives an outline of some of the steps that would be required of a feasibility study regardless of who constructs the plant. For an outside interest plant operator to

Well	BEFORE TREATMENT		AFTER KONTOL SQUEEZE TREATMENT	
	Tubing Failures Per Year	Iron Loss (Lbs/Day)	Tubing Failures Per Year	Iron Loss (Lbs/Day)
A	2	3.8	0	0.7
B	2	4.5	0	0.7
C	4	8.8	2	4.3
D	1	10.1	0	0.6
E	1.7	11.2	0	1.6
F	2	8.8	0	0.5
G	1.3	4.7	0	1.0
H	1.5	3.3	0	0.5
	15.5	55.4	2	9.9

another
TRETOLITE SERVICE
report

87% reduction
saves $52,000 annually

Squeeze Application of KONTOL* CORROSION INHIBITOR REDUCES TUBING FAILURES FROM 15.5 to 2 PER YEAR

A corrosion control program employing KONTOL substantially paid off on a Texas lease. Based on the cost of pulling wells and replacing corroded tubing, an average of $4,000 per job, the savings in one year (based on figures in table above) approximated $52,000.

HOW KONTOL PROTECTION WAS ACHIEVED

KONTOL Corrosion Inhibitor was squeezed into the well formations at the rate of 55 gallons per well, followed by 2 quarts of TRET-O-LITE* demulsifying chemical in 15 barrels of oil, followed by oil injection sufficient to displace the liquid in the tubing and force the chemical into the formation. Injection was obtained by means of a 5 g.p.m. triplex pump and 40 g.p.m. centrifugal pump.

COST OF TREATMENT

The KONTOL squeeze treatment cost about 70 mills per barrel of produced oil and 1.9 mills per barrel of fluid produced. This resulted in a treating cost of 17 mills per barrel less than previous corrosion prevention methods.

This is just one of many cost savings stories on KONTOL Corrosion Inhibitor treatment. For more —and information on how to start a KONTOL Corrosion Control Program—ask the Man in the Red Car. Or write to . . .

KF 59-1

*KONTOL *and* TRET-O-LITE *are registered trade-marks of Petrolite Corp.*

PETROLITE
CORPORATION

TRETOLITE COMPANY
DIVISIONS
369 Marshall Avenue, Saint Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

CANADA: Petrolite Corporation of Canada, Limited, 309 Alexandra Bldg., Edmonton, Alberta
COLOMBIA: South American Petrolite Corporation, Calle 19, No. 7-30, Office 807, Bogota
ENGLAND: Petrolite Limited, 46 Mount Street, London W. 1.
VENEZUELA: South American Petrolite Corporation, Hotel Avila, Caracas

REPRESENTATIVES

BRAZIL: WERCO, Ltda., Rua General Gurjao 326, Rio de Janeiro
GERMANY: H. Costenoble, Guiollettstrasse 47, Frankfort, a.M.
ITALY: NYMCO S.p.A. 9, Lungotevere A. da Brescia, Rome
JAPAN: Maruwa Bussan KK, No. 3, 2-Chome, Kyobashi, Chuo-Ku, Tokyo
KUWAIT: F. N. Dahdah, Box 1713, Al Kuwait
MEXICO: R. E. Power, Sierra de Mijes, No. 125, Mexico, D. F.
NETHERLANDS: F. E. C. Jenkins, Hoefbladlaan 134, The Hague
PERU: International Gas Lift Company, Apartado 71, Talara
TRINIDAD: Neal and Massy, Ltd., Port of Spain, P.O. Box 544

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

A National inspector performs a careful thread gauge check on Spang Extreme Line Casing.

One out of every five men inspects for you!

THE NATIONAL NSCO SUPPLY COMPANY

In the plant where we manufacture Spang Tubular Products, 20% of the employees are inspectors. They never compromise on Spang quality. Frequent and thorough inspection is another reason why Spang specialists set the standards by which all other oilfield tubular products are judged.

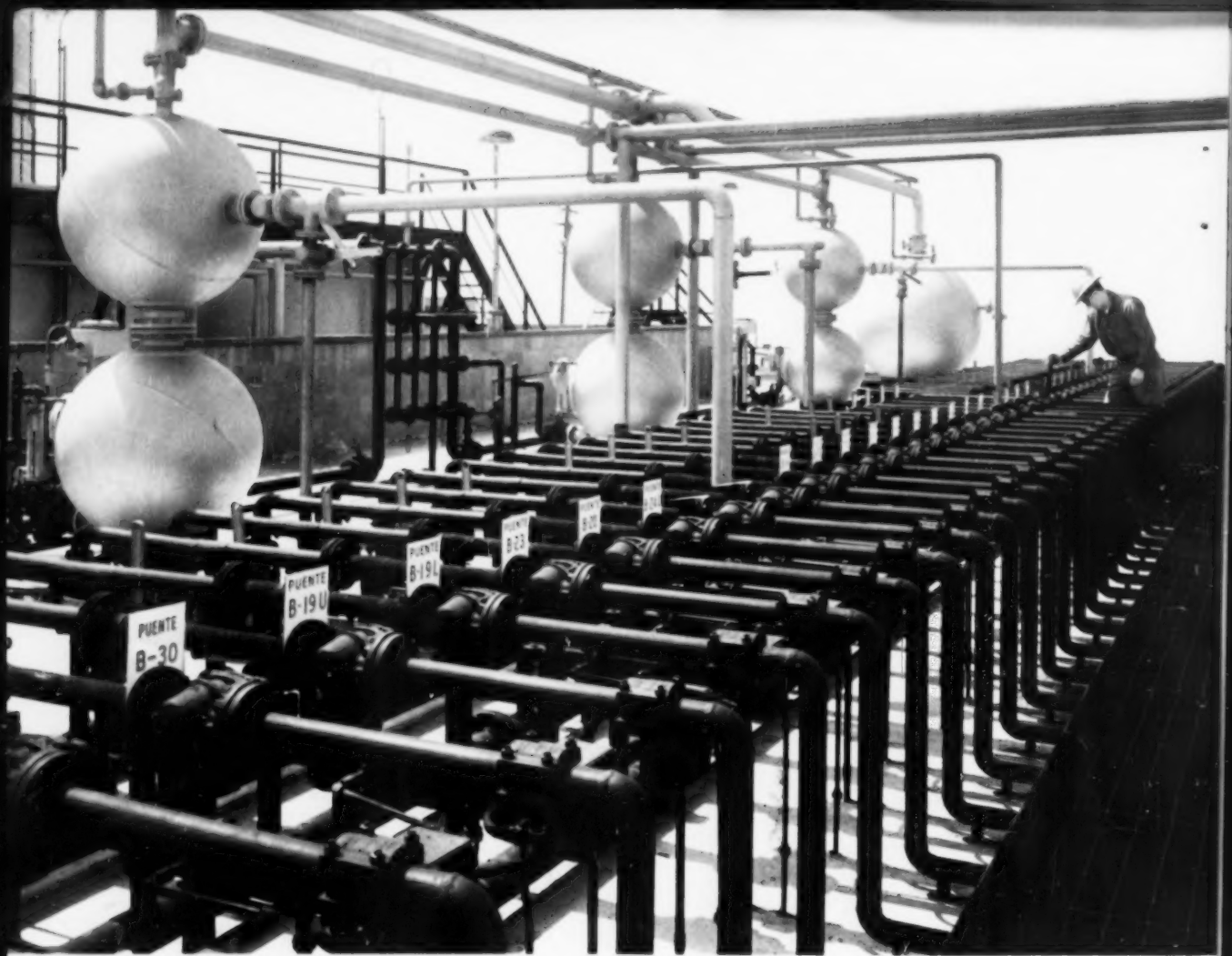
More on the next page

Why Spang Extreme Line Casing is specified for the world's deepest, high pressure wells

- 100% leak resistant
- Minimum major O.D.
- Minimum number of threaded connections
- Positive shoulder contact engagement which prevents overtonging
- Streamlined exterior and interior contours
- Easy to handle and stab
- Cannot be cross-threaded
- Available in grades for every well condition from National Supply—one source for superior oilfield tubular products!

Spang Extreme Line Casing has the mechanical and metallurgical properties to withstand high tensile loading, and to resist the severe pressures encountered in deep drilling.

More on the next page



Dependable Spang CW Steel Pipe is excellent for metering plant and tank farm lines. In addition to gas, oil and water lines, you can use it for roof rails, step rails and many other structural purposes.

Piping installations are easier with quality Spang CW Steel Pipe!

Spang CW is quality-controlled from skelp to finished product, and this control pays dividends on a wide variety of piping installations.

You save installation time and labor because Spang CW is easy to cut, bend, thread and weld. *Every* length is hydrostatically tested to insure uniform quality and long service life. The result is a stronger pipe with clean, tight welds and smoother finishes—inside and outside.

The best dividend is that you pay no more for this special quality pipe. All sizes of Spang CW—plain end, or threaded and coupled—are readily available through the nearest National Supply Store. Order now for your next job!

THE NATIONAL SUPPLY COMPANY

Subsidiary of Armco Steel Corporation

TWO GATEWAY CENTER, PITTSBURGH, PA.

DIVISION OFFICES: Calgary, Dallas, Denver, Houston, Toledo, Torrance, Tulsa

EXPORT: 600 Fifth Avenue, New York 20, N.Y., U.S.A.; City Wall House, Chiswell Street, London E.C.1

Litho in U.S.A.

Diamonds Mean Economical "Down to Stay" Drilling!

Due to the right combination of long-wearing diamonds and matrix engineering, Christensen Diamond bits stay on the bottom longer, reducing the non-productive man hours necessary to complete costly round trips. The excellent cutting action of diamonds requires less weight which produces a straighter hole, and, with no moving parts, the diamond bit reduces the possibility of additional round trips for replacement. Advantages like these mean a savings of time and money for you. Call your nearest Christensen field consultant, and he will recommend the right bit designed for your job. Call him today, and on your next drilling job let Christensen Diamond bits help you operate at "less cost per foot."

Diamonds Mean, "Less cost per foot."

CHRISTENSEN DIAMOND PRODUCTS

1937 SOUTH SECOND WEST • SALT LAKE CITY, UTAH

evaluate the plant installation would require as comprehensive a study as the producers would be required to make. "Bank Loans on Gasoline Plants," a paper by Frank E. McGonagill, gives a detailed study of gasoline plant economics from a bank loan standpoint. It discusses in detail four major items that a lending institution must know before it makes a plant loan. These are:

1. Gas reserves and producing rates,
2. Processing design and equipment,
3. Economic factors,
4. Legal considerations.

If the plant is placed in operation on the main transmission line, the transmission company will generally take one of the following positions:

1. Install and operate the plant and return part of the recovery to the producers.
2. Own the plant with the field operators and participate in the liquid recovery.
3. Take no part in the plant operation or ownership, but require that the plant operators make the transmission line "whole" as to both volume and Btu content for gas shrinkage and loss in the plant operation.

There are other possibilities, but these are three of the more common now in operation.

The outside interest plant owner usually makes his bank loan and investment on a five-year payout basis and returns the products to the producers on a sliding scale based on volume of liquids processed and average sales prices. Table 1 shows this type schedule and will be used in this study.

TABLE 1. Excerpt from Gas Sales Contract.

Schedule I: Settlement Variation with Price Received

Price — Cents per gal	Percent to Producer — Based on Price
Less than 3.75	30
3.75 — 4.25	40
4.25 — 4.75	45
4.75 or more	50

Schedule II: Settlement Correction for Volume Sales

Gallons Recovered of Total and Saved from Inlet Stream	Percent of Percent to Producer from Schedule I
less than 32 M	50
32 — 34 M	60
34 — 36 M	70
36 — 38 M	80
38 — 40 M	90
40 — 42 M	100
42 — 44 M	105
44 — 46 M	110
46 — 50 M	115
50 M — or more	120

Note: All brackets in both schedules above are to be construed to include lowest figure but not the highest figure.

Since this is to be an outside plant operation, the field producers would get their portion of the income from liquid products as shown by the schedules on Table 1. The average price per gallon as previously determined was 4.53 cents per gal. The total plant recovery was 395 MM gal over the entire life of the plant. This is equivalent to 54,000 gal per day for a 20-year life.

From Schedule I the producer receives 45 percent of the gross proceeds (4.53 cents per gal) and from Schedule II the producer receives 120 percent (54,100 gal per day)

TABLE 2. Outline of Steps Necessary to Prepare a Feasibility Study of a Typical Gasoline Plant Project

A. Inception of Plant Project Idea
   Shortly after discovery well is completed
B. Preliminary work
   1. Initial reserves — geologists, reservoir engineers
   2. Retrograde PVT study on gas sands — company lab or commercial lab
   3. PVT study on oil sands same as B-2
   4. Type of field or lease equipment to be used — production people
C. Plant Study
   1. Gas contract data Interstate or Intrastate Rateable take
      1 MMpd/8 MMM res (21.9 yr life)
      1 MMpd/10 MMM res (27.3 yr life)
      1 MMpd/7.3 MMM res (20.0 yr life)
      Fluctuation of take
      Change of composition with pressure decline or time
D. Plant Recovery
      Propane 60-80 %
      Butanes 90-95 %
      Pentanes Plus 98-100%
      Type of products and gasoline
      Is gas residue available for sale?
E. Type of Plant
   1. Absorption
   2. Refrigeration
   3. Adsorption
F. Plant Design
   1. Site selection
   2. Gathering system
      a. type
      b. pressure
      c. equipment
   3. Size
   4. Cost
G. Value of recovered products
   1. Gasoline (RVP)
   2. Propane
   3. Butane
   (Obtained from Platts Oil Gram or other source with particular emphasis to plant location—value is generally held constant for each of products throughout project life.)
H. Annual Gross Income
I. Operating Costs
   1. Direct labor & benefits
   2. Material
   3. Taxes
   4. Maintenance
   5. Overhead
   6. Royalty
   7. Shrinkage and fuel
J. Net Income
   (Before federal income taxes and depreciation)
K. Payout
   Plant investment divided by net income (before income tax and depreciation)
L. Depreciation
   1. Type
      a. Rapid
      b. Straight line
      c. Sum of the rights
      d. Declining balance
M. Rate of return
N. Farmout possibilities

of the percent received from Schedule I. Therefore the total amount received will be:

$$(0.45)\ (1.20) = 54 \text{ percent}$$

This is equivalent to a gross income to the producer as:

	Interstate	*Intrastate*
Daily	$ 1,323	$ 2,646
Monthly	40,200	80,400
Annually	482,000	964,000
Life	9,640,000	9,640,000

This is the income that grosses to the producer. It is subject to expenses, but is not subject to percentage depletion. It requires the full income tax treatment on the net income. ★ ★ ★

FORMATION PACKER SHOE
OPERATING DIAGRAM

CEMENT YOUR FUTURE... WELL!

WITH THESE HALLIBURTON CEMENTING TOOLS

HALLIBURTON FORMATION PACKER SHOE AND COLLAR used in casing cementing helps to protect exposed low pressure formations or any formation below the casing... minimizing subsurface problems... helping to attain maximum future oil production.

Halliburton Formation Packer Shoes offer these outstanding advantages when installed on the first joint of a string of casing:

- Helps protect the pay zone from cement contamination in low-pressure formations while cementing, as Packer when expanded packs off open hole below casing.
- Floats in and guides the casing to bottom.
- Halliburton Super-Seal Back-Pressure Valve above slotted cementing ports helps keep cement slurry in place with no backing-up inside the casing.
- Circulation of fluids is provided through end of Shoe until shoe packer rubber is expanded and set.

This Formation Packer Shoe is used in all areas where conditions require casing to be set on top of producing formation. All internal parts are constructed of high impact phenolic plastic for fast, easy drilling.

Halliburton Formation Packer Collar is similar in design, casing size, hole size, application and setting operation to the Formation Packer Shoe... providing multiple uses in cementing casing.

- Installed on casing above shoe joint, helps protect a lower formation from cement contamination while cementing.
- Several joints of casing or liner may be installed on lower end of Packer Collar; packer is set and cement pumped down casing and out through slotted cementing ports into annulus above expanded packer.
- Used in setting liners, perforated pipe and screen in salt water disposal wells, water flooding projects and in fields where "Full Hole" cementing is desirable.
- Designed to support 40, 400 to 114,000 lbs. suspended below packer collar depending upon O.D. size required.

FORMATION PACKER SHOE
CASING SWIVEL

Put your well on a solid foundation... specify Halliburton Formation Packer Tools to help solve specific problems in oil well cementing. Write for a copy of new brochure number S-8025.

TOP PLUG BAFFLE BOTTOM PLUG

HALLIBURTON SPECIAL PLUG AND BAFFLE SET... may be placed one or more joints above Packer Shoe in a Casing Collar in the string to stop the top cementing plug. A Special Bottom Plug is pumped down through the Baffle to Setting Cage and applied pressure ruptures the plug diaphragm to establish circulation through plug and cementing ports... Top plug is pumped down on top of the cement slurry and shut-off on the baffle.

HALLIBURTON CEMENTING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

"A WELL WORTH CEMENTING IS WORTH CEMENTING WELL"

OVER 55,000 RENTAL ITEMS

the world's largest selection of oilfield rental tools.

HOMCO
HOUSTON OIL FIELD MATERIAL COMPANY, INC.
ASSOCIATED OIL FIELD RENTALS

Homco-Associated offers you the largest selection of oil field rental tools in the world. With thirteen strategically located yards in the heart of the oil country, they are as close to you as your telephone.

Whatever your needs may be in the field of rental tools, your best bet is to call the **Homco-Associated** office nearest to you. You are assured that your call won't be wasted. You'll get the equipment you need and get it fast.

Whether it's pipe tongs or drill collars, blow-out preventors or adapter flanges, tubing spiders or Kelleys—we've got them, in top condition, ready for you. Call us and see what good service really is.

LOCATIONS

Texas: Alice, Beaumont, Houston, Odessa, Snyder • **Oklahoma:** Duncan, Oklahoma City • **Louisiana:** Harvey, Lafayette, Morgan City • **Mississippi:** Laurel • **New Mexico:** Hobbs • **Wyoming:** Casper

HOMCO HAS IT!

NORRIS MAKES FINE SUCKER RODS . . .
WE DO APPRECIATE YOUR BUSINESS

NORRIS TYPE 30
Carbon-Manganese Fully Normalized. Heavy duty where corrosion is not a major problem.

NORRIS TYPE 35
Nickel-Chromium-Molybdenum Alloy, Normalized and Tempered. Medium to Heavy duty in corrosive conditions.

NORRIS TYPE 40
Nickel-Molybdenum-Alloy Normalized and Tempered. Heavy pumping duty in Medium Corrosive Conditions.

NORRIS TYPE 75
Nickel-Chromium-Molybdenum Steel Normalized and Tempered. Extremely Heavy Duty with Mildly Corrosive Fluids.

NORRIS QUALITY
SUCKER RODS
POLISHED RODS - COUPLINGS

W. C. NORRIS, MANUFACTURER
DIVISION OF DOVER CORPORATION
TULSA, OKLAHOMA

BRANCHES: Great Bend, Kansas; Corpus Christi, Houston, Kilgore, Odessa, Wichita Falls, Texas; Oklahoma City, Oklahoma; Salem, Illinois; Casper, Wyoming; Farmington, New Mexico; Edmonton, Alberta, Canada.

Buy From Your NORRIS Distributor

HYDRAULIC PERFORATING

Service companies open new field — using a fluid, an abrasive, and high pump pressures

Advantages include:

- **Controllable and practically unlimited depth of penetration**
- **Elimination of cement shattering**
- **Treatment, additional perforating, and subsequent production without killing well or tripping the tubing**

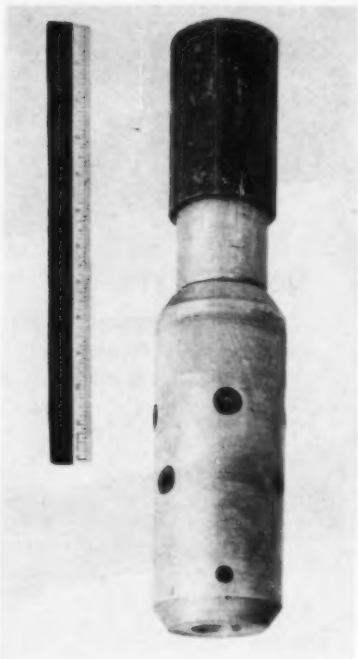


FIG. 1. **Perforating tool** used in hydraulic perforating process. Orifices may be blanked off to permit various perforating patterns. This is the Dowell tool.

HYDRAULIC PERFORATING is a process of pumping a fluid and an abrasive to erode a hole through the pipe, cement and into the formation. The new service, now being offered by two service companies, is fast being found as a quick, effective and economical method to: Enlarge well bore diameters; remove scale or other deposits from the faces of producing formations; and perforate casing without the use of explosives.

The erosion of sand on metal is well known to the oil industry — for example, sand erosion of ball and seats in pumps, pump head, line pipe, production tubing, etc. For the past several years attempts have been made to harness this force and put it to a practical use. Hydraulic perforating has resulted.

Advantages

The process suggests several advantages:

1. Controllable and practically unlimited depth of penetration.
2. Controllable and larger entry hole diameter.
3. Elimination of cement shattering and consequently elimination of communication problems.
4. Cleaner perforations.
5. Elimination of casing damage.
6. Complete well stimulation (perforating, acidizing and fracturing) with one equipment set-up.
7. Treatment and subsequent production of well without killing or tripping the tubing.
8. Repetitive perforating and testing without tubing trips, excessive rig time and equipment costs.
9. Smooth regular perforations to facilitate ball sealer operations.

Hydraulic Perforating 'Tools'

In this service, the tool — a hollow tube containing a specified number of small jets in a chosen perforating pattern — is attached to the tubing string and lowered into the well. Fluid can be water, oil, inhibited acid or other liquids. Abrasive material can be sand, steel pellets, flint or similar materials. Standard pump trucks provide necessary hydraulic horsepower to give cutting force to the jet stream.

Tools used in the process are specifically designed for this function. Basically the tool consists of a barrel with threaded holes, a threaded bushing, and a special orifice insert.

Two service companies are now making the process available. Dowell division of the Dow Chemical Company is offering the service under the Abrasijet name; The Western Company's service is called Sandril.

In practice, the high-velocity jet stream actually scours the rock, enlarges the well bore and removes deposits that clog flow channels. In cased wells, the method is used to perforate the pipe. Tests indicate that perforations are made in as little as 20 sec. The well can then be acidized or fractured without removing the tool from the well. Acidizing can be done by pumping the chemicals down the tubing or annular space. Fracturing can be done in the same manner.

Tool Specifications

Already the companies are offering the service in several forms to meet various perforating needs.

Dowell's tool is 3¾-in. in diam and 12-in. long, with an internal diameter of 2-in. The design is such that combinations of two, three, four, and five or seven jets may be used. The jet openings are positioned with four openings on one plane and three in another. The jetting nozzles are made of hardened steel alloys with a 3/16-in. outlet (Fig. 1).

This company has designed its tool so that the abrasive jet perforating may be multi-staged. For example, in a

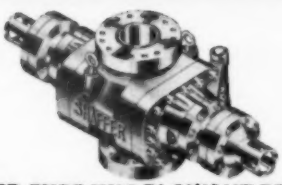
(Continued on page B-92)

4 Top Examples of Shaffer Leadership!

IN BLOWOUT PREVENTERS

Shaffer Blowout Preventers not only give you **quality without compromise** but also give you the industry's widest selection of control gates, each incorporating unique performance advantages found in no other make of equipment. This is why leading operators have made SHAFFER equipment their top choice for modern well control!

for Extra High Pressures!



SHAFFER TYPE XHP BLOWOUT PREVENTERS

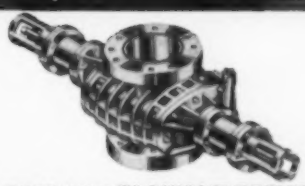
Three sizes are available in Type XHP Preventers . . . 7-1/16" bore size for *working* pressures to 15,000 PSI (tested to 22,500 PSI) . . . 9" and 11" bore sizes for *working* pressures to 10,000 PSI (tested to 15,000 PSI)

- **XHP Preventers feature "In-Line" ram and piston design, with no levers, yokes or other complicated connections between each ram and its operating piston. They are simple to install, positive in operation!**
- **XHP Preventers are also very easy to service. Their "Swinging End - Opening" design assures quick, simple ram changes without loss of operating fluid and without breaking hydraulic connections!**

These are typical of the many advancements that make XHP Preventers the finest available for *extra high* pressure protection.

For further details write for Bulletin No. 1000!

for "Quickie" Jobs!



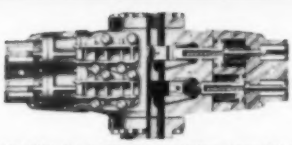
SHAFFER TYPE LWS BLOWOUT PREVENTERS

Lightweight and easy to move from rig-to-rig, LWS Preventers are ideal for quick "in-and-out" production and re-work jobs where time is a particularly vital factor.

- **LWS Preventers can be operated by a portable hand pump that eliminates need for installing the usual hydraulic piping and accessory equipment. With this portable hand pump they can be opened or closed in 15 to 20 seconds. Or they can be opened or closed in as little as 2 to 7 seconds with a choice of hydraulic power units.**
- **LWS Preventers have all the latest Shaffer design features . . . "Swinging End-Opening" doors for changing rams without loss of hydraulic fluid . . . positive, simple "In-Line" ram and piston design for direct, foolproof operation of rams . . . and many other unique Shaffer advantages.**

Bulletin No. 1001 outlines many other Type LWS features. Write for it!

for General Drilling!



SHAFFER TYPE B AND TYPE E BLOWOUT PREVENTERS

Type B has *non*-rising locking shafts for maximum compactness . . . Type E has *rising* locking shafts for quick indication of ram position.

- **Both types feature the convenience of "Swinging Side-Opening" doors for easy ram changes without loss of hydraulic fluid . . . and positive "In-Line" ram and piston design that eliminates yokes, levers and other complicated assemblies.**

For general drilling operations the Shaffer Type B or Type E Preventers are unequalled in efficiency, safety and trouble-free simplicity.

The Shaffer General Catalog describes many other features. Send for it!

for Continuous Protection!

SHAFFER ROTATING BLOWOUT PREVENTERS AND STRIPPERS

As long as the drill string is in the hole, Shaffer Rotating Blowout Preventers and Strippers maintain continuous pressure control *automatically*. They adjust automatically to fit the varying diameters of drill pipe, couplings and tool joints, as well as the varying shapes of square, hexagon and octagon kellys. No special drill string equipment is required.

- **Furthermore the pressure-tight seal is maintained continuously whether the drill string is being raised or lowered, is rotating, or is stationary.**
- **These units are ideal for regular drilling, for drilling under pressure, for reverse circulation and for drilling with air or gas instead of mud.**

Bulletin No. 1003 has complete information. Send for it!

36 years OF OIL TOOL LEADERSHIP

NO MATTER WHAT YOUR PRESSURE CONTROL REQUIREMENTS, Shaffer can fill them with equipment of dependable, **field-proven** design. See your nearest Shaffer representative for complete details—or write direct!

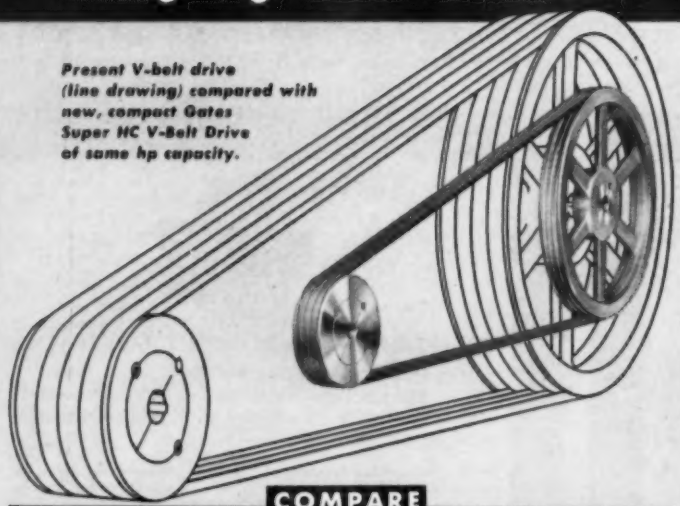
SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

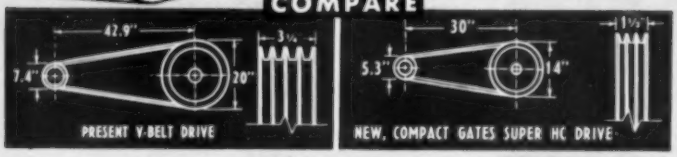
SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Shaffer Tool Works, 6701 South Shields Boulevard
FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 546
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
HOUMA, LOUISIANA, Shaffer Tool Works, Post Office Box 827
EXPORT SALES OFFICE, Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

Designing NEW DRIVES?

Present V-belt drive (line drawing) compared with new, compact Gates Super HC V-Belt Drive of same hp capacity.



COMPARE



Save up to 20%

with new high capacity V-belt drive

When you change the whole drive—on mud pump, pumping unit, or any other piece of petroleum equipment—remember: The cost of a Gates Super HC V-Belt is as much as 20% less than the cost of present V-belt drives of the same horsepower capacity.

A development of Specialized Research in the world's largest V-belt laboratories at Gates, the new Super HC V-Belt makes possible the most compact, lightest-weight, lowest-cost multiple V-belt drive you can put on any pump!

Cuts drive space as much as 50%

With Gates new Super HC V-Belt, sheave diameters and widths can be reduced 30% to 50%, center distances 20% and more. Bearing load is lightened and total space occupied by the drive may be cut as much as 50%.

"The Modern Way to Design Multiple V-Belt Drives" is an informative handbook on the Super HC Drive, available from your nearby Gates Distributor listed in the Yellow Pages of your phone book.

For NEW drives on mud pumps Gates compact new Super HC V-Belt with the patented ribbed top cuts space required up to 50% and cost as much as 20%.

The Gates Rubber Co., Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ont.
World's Largest Maker of V-Belts

TPA 439A

Gates SUPER HC V-BELT Drives

That Crazy Name!

Ever wonder how oil fields get those weird and fanciful designations? Like Big Foot, Lost Soldier, Toe Nail, Turtle Bayou, Mustang Island, Big Dome, and so on?

Most are rather prosaic in their origin, but some have fascinating glimpses of Americana in their background, according to the Oil Industry Information Committee of the American Petroleum Institute.

The committee says that the naming of oil fields is probably the most casual thing that oil men do — but in their own way, these colorful appelations highlight the human side of a hard-hitting, fast-moving industry, and emphasize how inextricably oil and oil men are tied in with this nation's lusty growth and development.

Out in Southern Oklahoma, for example, there's a field that got its name from a friendly greeting. It stems from the fact that an oil writer who covered the area habitually greeted oil men with the Hebrew phrase "Sholem Alechem," which means "Peace be with you." The phrase caught on, and when a field was brought in back in 1923, it was given the name that was on everyone's lips . . . the Sholem Alechem field.

Lost Soldier field is another interesting example. Back in 1880, a trooper attached to the Fort Steele, Wyoming, barracks got lost in the vast and barren countryside of Central Wyoming. Knowing full well that Army stragglers were choice game for Indian war parties roaming the area, he decided to sit tight until scouts from the fort could find him. He was rescued subsequently, near death and exhaustion. Years later, when a field was brought in nearby, it was named the Lost Soldier field.

Toe Nail field in Schleicher County, Texas, is about as colorful Americana-wise, as they can get. A cattleman by the name of Jeff Thompson had a store in the front part of his ranch house. He prospered, and so did the region. As one of the leading citizens, he was given the honor of naming the area. When he told the group that he had prospered because he had gotten a "good toe nail hold," a new oil field name was born.

The Big Foot field in Frio County, Texas, was named for a nearby community, but like the Lost Soldier field, it has a bit of historical lore, too. According to legend, William Alexander "Big Foot" Wallace was famed equally as a Texas Ranger, Indian fighter, hunter, and a man well equipped by nature to stomp out grass fires. Eventually, the little crossroads town be-

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

came known simply as "Big Foot," and the name carried over to the oil field.

In West Texas, another field has the curious name of TXL. When the new field was discovered, it was decided to name it after the owner of the land, the Texas Pacific Land and Trust Company. Even for a Texas oil field, it was agreed that this was a mighty long handle. To simplify things, they took the company's code name on the New York Stock Exchange, and dubbed it the TXL field.

The New York City field happens to be located in North Texas, thousands of miles from Times Square. It got its name because the only landmark in the area where the geologists were working was a roadside store four miles away on which some waggish former owner had hung the ambitious name, New York City!

Other curious and colorful names include:

Embar — because cattle grazing around the discovery well carried the M bar brand of a nearby ranch.

Medicine Bow — birchwood growing in this region was abundant and of exceptionally high quality, and the Indians used to come here to stock up with bows and arrows.

Bowlegs — named after Bowlegs, a nearby town, whose name supposedly came from a Seminole Indian who had been nicknamed "Bowlegs."

Hogshooter pool — named for a creek in Oklahoma, along which early settlers used to shoot wild hogs.

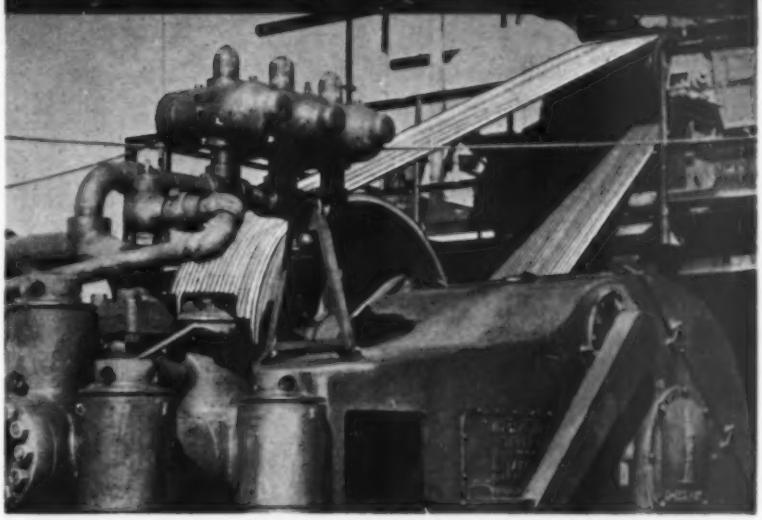
In general, the majority of field designations fall into three categories — towns, topography, and people.

Thus, many fields bear the names of adjacent towns, like Richey and Glendive, Montana; Benton, Illinois; and Burtville and Happytown, Louisiana. There are such fields as Rattlesnake field, named for a Kansas creek; South Mountain, Signal Hill, and Brea Canyon in California. Individual names include such as Glen Pool, south of Tulsa, Oklahoma, which came in on the Ida Glen Farm; the Yates field in Pecos County, Texas, named after a pioneer cattle raiser, and so on.

Basically, however, there is no accepted pattern for naming new oil fields. Most states, nowadays, exercise some control though by requiring approval by the group that administers their oil and gas matters.

In Texas, for example, an operator must submit three preferences to the Texas Railroad Commission, the regulatory body. Unless there is some conflict, the first usually is approved. So it goes in the industry, as geologists and other exploration crews probe through mountains and deserts, swamps and forests in their constant search for oil.

Need REPLACEMENT V-BELTS?



Improved Gates Vulco Rope gives you 2 important advantages

1. 40% higher hp rating at no increase in price: This important cost-saving advance is the result of Specialized Research in the world's largest belt-testing laboratories at Gates. **As replacements on standard drives these V-belts with 40% more load-carrying ability give longer service life...reduce down-time, cut belt replacement costs.**

2. Concave Sides (U.S. Patent 1813698): The sides of Gates Belts are concave. When the belt is bent around the sheave, the concave sides fill out — become straight — for full, uniform contact with the sides of the sheave groove. Uniform contact insures maximum pulling power...even distribution of wear...longer life.

Available in all sizes from your nearby Gates V-Belt Distrbutor listed in the Yellow Pages of your phone book.

For REPLACEMENT V-belts on mud pumps Gates Vulco Rope with patented ribbed top is first choice of drillers all over the world.

When designing new drives use Gates new Super HC Rib-Top V-Belts. See opposite page.

The Gates Rubber Co., Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ont.

World's Largest Maker of V-Belts

TPA 432A

Gates Hi-Power VULCO ROPE V-Belts

three-stage tool, lower perforations are first made. To close operating jet in the lowest section and open the second jet, a ball is pumped down the tubing to seat in a sleeve between these two sections. When the second stage is completed, the second set of jets are closed and the third set of orifices are opened by a second ball. See Fig. 3.

Western offers two basic tools—one to initiate a conventional perforation pattern, and one to open perforations in a single fracture plane. Several sizes of tools are being used (Fig. 2).

For perforating 2½-in. casing, a tool with an OD of 1¾-in. is used; the jet opening in this tool is 5/32-in. A 2½-in. OD tool is used in 4½-in. casing. A 3½-in. OD barrel is used in 5½-in. casing; 4½-in. OD tool is used in

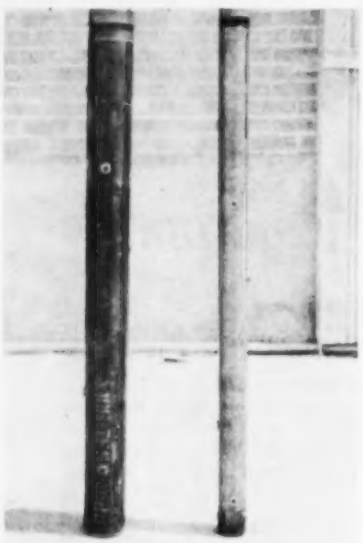


FIG. 2. **Two perforating tools** of different sizes, designed to run in different size casing. These tools, 4 ft long, are used by The Western Company.

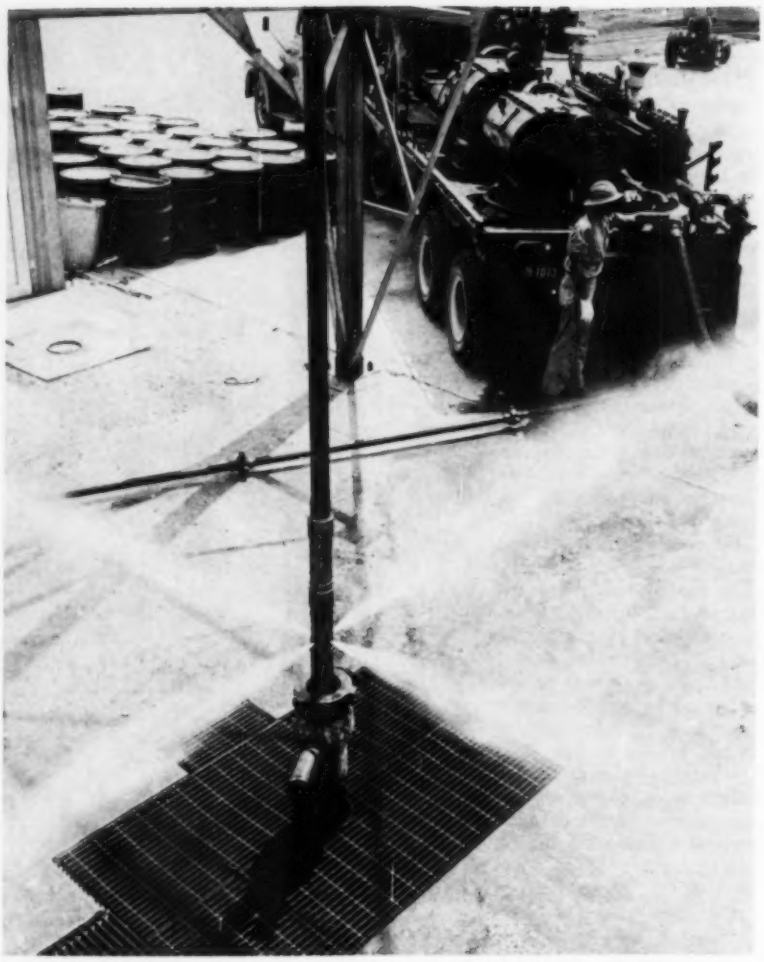


FIG. 3. **Four jets open** are seen here in this test of Dowell's three stage tool. Here, the jet pressure was only 500 psi and fluid flow rate was approximately 30 gal per min.

7-in. casing, and 6-in. OD barrel used in 8⅝-in. casing. Most of these tools have jet openings of 11/64-in. in both conventional and single fracture plane designs.

Both companies may alter the perforation number and pattern by blanking off ports in the tool.

Tool Abrasion

Tests made by Dowell engineers in the laboratory and field indicate that a jet pressure of 2000 psi or more, a fluid injection rate of 50 gal per min or more per jet will permit rapid perforation of casing and the cement sheath.

The very concept that makes this method possible, however, is death to the tool itself. Research in metallurgy and jet design is expected to provide longer jet life and more economical service.

Dowell overcomes the abrasion problem and provides a large number of controlled size perforations without tripping the tubing by making use of its multi-stage tool. When large numbers of perforations are being made, the simple valving arrangement utilizing a ball and sleeve is used to blank off worn jets and to open new ones and continue perforating up the hole without pulling the tool to the surface.

Western finds that its orifice bushings should be replaced after a total of 9 to 12 minutes pump time with sand. A new orifice material will be available very soon that will increase orifice life to at least 25 to 30 minutes. Pumptime with clear fluid has very little effect on the tools. Some of the tools are threaded on both ends to allow the use of several specialty tools, such as a circulating port, a latch-on for repositioning temporary bridging plugs, etc. This company's tool can make up to 100 perforations or more economically, by repositioning or staging the tubing and tool. The tool is then removed for fracturing operations, may be left in the well for production, or sheared off the tubing and allowed to drop to the bottom of the hole.

Field Tests

The number of perforations which are possible at any one setting is dependent upon the size of tubing, friction characteristics of fluid, depth of the well, and tool design. Generally about three minutes jetting time is required per each single series of holes made. This is true for single fracture plane or conventional pattern.

for PRODUCTION SECURITY
specify LUFKIN . . .

IT'S CHEAPER TO BUY THE BEST
. . . *and avoid that costly "down-time"*

You Can Relax When Your Lease Is **LUFKIN EQUIPPED**

PLENTY OF "BEEF" WHERE IT COUNTS THE MOST

Long years of experience have proven the absolute necessity for the generous factors of safety designed into the gears, shafts, bearings and structural members of LUFKIN UNITS

Lufkin **FOUNDRY & MACHINE COMPANY**

LUFKIN, TEXAS

Branch Sales and Service: Houston • Natchez • Corpus Christi • Lafayette • Dallas • Kilgore • Odessa • Hobbs • Oklahoma City • Shreveport • Wichita Falls • Los Angeles • Bakersfield • Effingham • Casper • Denver • Sidney • Great Bend • Midland • Farmington • Seminole • Tulsa • New York • Pampa • Sterling • Maracaibo, Venezuela

Lufkin equipment in Canada is handled by
THE LUFKIN MACHINE CO., LTD., 9950 65th Avenue, Edmonton, Alberta, Canada, Regina, Saskatchewan, Canada

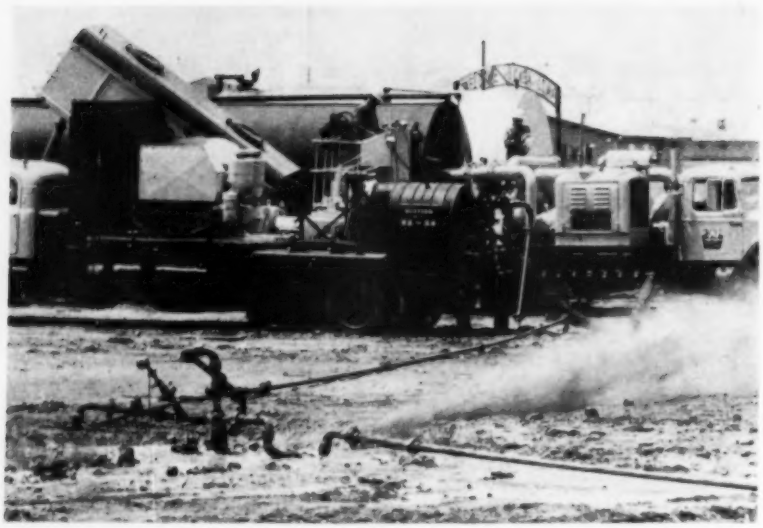


FIG. 4. **Near surface test of** a Western hydraulic perforating tool. The tool has just penetrated 5-in. casing set in a 55-gal bbl filled with cement, and has cut a 20 to 30 ft path through caliche soil. Time 3½ min.

There are no real limitations to the process for extreme depths or unusual applications, as exhibited in field tests to date.

Numerous pilot well tests have been performed during the development of the process. Results of these tests have indicated that several feet of penetration into a formation may be obtained if desired. Note the near-surface test illustrated in Fig. 4.

A Western pilot well test consists of 5½-in. 17 lb J-55 casing set in neat cement. Tool was positioned on 2-in. tubing. Water and 20-40 frac sand was used as the perforating fluid. The fluid and sand mixture penetrated the 5½-in. casing, 6-in. of cement, and approximately 20 ft into the surrounding caliche formation in a period of 3½-minutes.

Successful well tests have also been performed with impressive results.

A typical Sandril well test consisted of pumping 14 bbl of lease crude and 2 lb of 20-40 frac sand per gal down 4379 ft of 2-in. tubing. The fluid and sand was pumped from the tool for 3 min. Flowing production resulted from previously unperforated pipe. Well tests to a depth of 7500 ft have been successful.

One well at 1500 ft in open hole produced 2 bbl of fluid per day; after this company's single fracture plane treatment the well produced 149 bbl of fluid per day.

To cite a Dowell case history, the service can successfully perform other functions — in this case, hole enlargement.

A waterflood input well was taking an insufficient volume of water. This well was an old producer that had been converted to an input well. It had been plugged back with cement, drilled out, and shot with nitroglycerine. Subsequent acidizing and open hole shoot-

ONE OF THESE OTIS TUBING SAFETY VALVES SHUT IN THIS WELL
WHEN IT THREATENED TO BLOW WILD, AND SAVED US THOUSANDS OF DOLLARS
IN LOST PRODUCTION AND A POSSIBLE SERIOUS FIRE.
First in Pres
THE WELL WAS PRODUCING 2½ MMCFD OF GAS WITH 89 BD OF SAND-LADEN OIL WHEN A LEAK DEVELOPED AT THE FLANGE OF THE MASTER VALVE. AT THE TIME, THE FLOWING PRESSURE WAS 3,100 PSI, SO IT DIDN'T TAKE LONG FOR THE GAS AND SAND TO CUT OUT A SIZABLE HOLE. AS SOON AS THE PRESSURE DIFFERENTIAL EXCEEDED THE VALVE SETTING, THE OTIS VALVE AUTOMATICALLY SNAPPED SHUT.
THIS MORNING WE PUMPED DOWN THROUGH THE SAFETY VALVE AND KILLED THE WELL WITH WATER—THEN BROKE OUT THE MASTER VALVE TO REPAIR THE LEAKY CONNECTION. NOW WE'RE RESETTING THE TREE. WE CALLED OUT OTIS TO PULL, CHECK, AND REDRESS THE SAFETY VALVE BEFORE WE PUT THE WELL BACK ON PRODUCTION. THE VALVE'S PROBABLY O.K., BUT IT'S BEEN DOWN THERE 10 MONTHS AND UNDER OUR SAFETY PROGRAM WE PULL ALL OF OUR SAFETY VALVES PERIODICALLY FOR INSPECTION ANYWAY.

ing failed to increase injectivity. The well was then treated with Abrasijet, and the injection capacity was increased from 5 to 25 bbl of water per day. Caliper surveys were run before and after treatment. As indicated by a comparison of the two surveys, the hole was enlarged considerably. Total jetting time on the job was 18 minutes. Materials used were 1250 gal of 15 percent inhibited acid and 2500 lb of sand (Fig. 5).

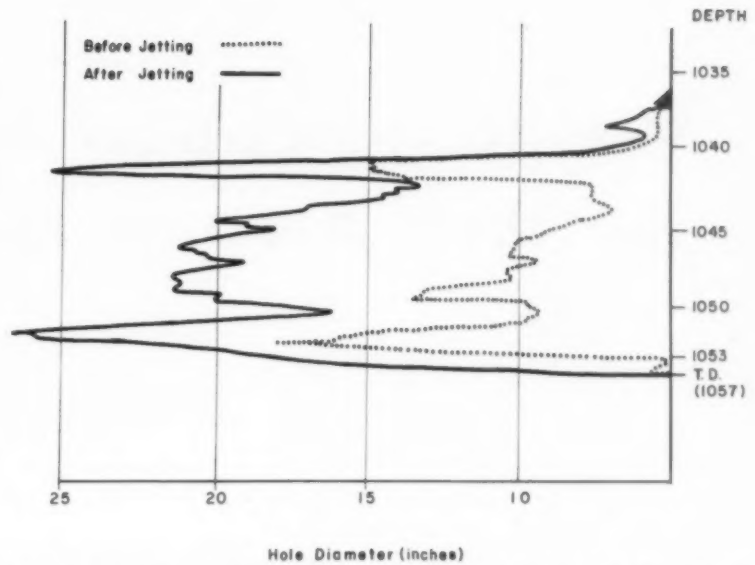


FIG. 5. **Caliper surveys** before and after jetting in open hole section of a water input well. Treatment permitted operator to put away five times more water than prior to scouring Abrasijet treatment.

Future

The hydraulic perforating process is one of the most significant innovations in well completion and stimulation since hydraulic fracturing. The process is in its infancy and offers an unlimited area for improvement and development. Several are in progress. They include:

1. A means for running a log without using wireline equipment in conjunction with the tool.

2. Improvement of orifice insert material to allow greater pump time with less wear.

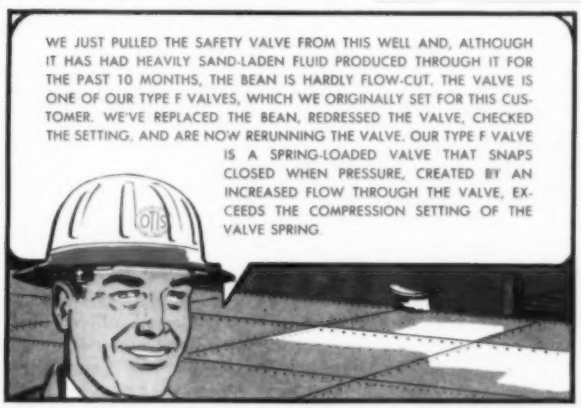
3. Specialty tools to allow various downhole operations in conjunction with perforating operation without requiring tubing trip. These include circulating port, latch on, casing collar locator, hold-down tool, packer, etc.

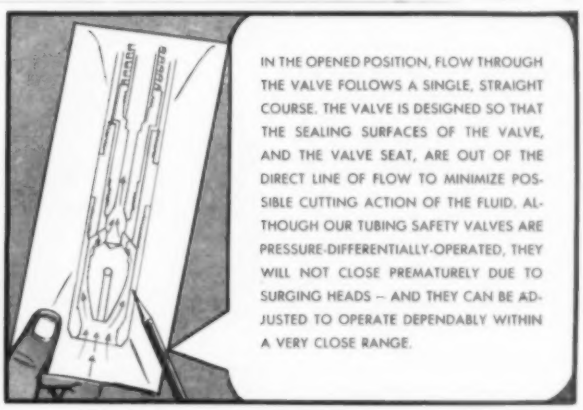
4. Device for underreaming casing or cutting casing.

5. Tools to allow perforation of any size or type casing.

6. Means for removing hydraulic perforating tool without pulling tubing.

7. Greater knowledge of process variables — penetration, penetration rates, etc., permitting greater flexibility in job design. ★ ★ ★


WE JUST PULLED THE SAFETY VALVE FROM THIS WELL AND, ALTHOUGH IT HAS HAD HEAVILY SAND-LADEN FLUID PRODUCED THROUGH IT FOR THE PAST 10 MONTHS, THE BEAN IS HARDLY FLOW-CUT. THE VALVE IS ONE OF OUR TYPE F VALVES, WHICH WE ORIGINALLY SET FOR THIS CUSTOMER. WE'VE REPLACED THE BEAN, REDRESSED THE VALVE, CHECKED THE SETTING, AND ARE NOW RERUNNING THE VALVE. OUR TYPE F VALVE IS A SPRING-LOADED VALVE THAT SNAPS CLOSED WHEN PRESSURE, CREATED BY AN INCREASED FLOW THROUGH THE VALVE, EXCEEDS THE COMPRESSION SETTING OF THE VALVE SPRING.
OTIS


IN THE OPENED POSITION, FLOW THROUGH THE VALVE FOLLOWS A SINGLE, STRAIGHT COURSE. THE VALVE IS DESIGNED SO THAT THE SEALING SURFACES OF THE VALVE, AND THE VALVE SEAT, ARE OUT OF THE DIRECT LINE OF FLOW TO MINIMIZE POSSIBLE CUTTING ACTION OF THE FLUID. ALTHOUGH OUR TUBING SAFETY VALVES ARE PRESSURE-DIFFERENTIALLY-OPERATED, THEY WILL NOT CLOSE PREMATURELY DUE TO SURGING HEADS -- AND THEY CAN BE ADJUSTED TO OPERATE DEPENDABLY WITHIN A VERY CLOSE RANGE.

OTIS TUBING SAFETY VALVES, OR "STORM CHOKES" AS THEY'VE BEEN CALLED FOR YEARS, CAN BE RUN IN AND LANDED UNDER PRESSURE IN OTIS NIPPLES MADE UP IN THE TUBING STRING, OR SET IN THE TUBING ON SLIPS FOR WELLS WITHOUT NIPPLES. OTIS TUBING SAFETY VALVES, SET BY OTIS CREWS, HAVE NEVER FAILED TO SHUT IN A BLOWOUT. CALL THE OTIS OFFICE NEAREST YOU AND TALK TO THEM ABOUT INSTALLING TUBING SAFETY VALVES -- BEFORE YOU NEED THEM. A SMALL INVESTMENT IN AN OTIS STORM CHOKE TODAY CAN PROTECT YOU AGAINST A POSSIBLE FIRE OR WILD WELL TOMORROW. PLAY IT SAFE WITH A SAFETY PROGRAM -- CALL OTIS!
OTIS - "First in Pressure Control"
OTIS ENGINEERING CORPORATION
General Offices: 6612 Denton Drive · Dallas
Branches Throughout the Oil Country
OTIS

Pre-Registration Arranged for 19th AAODC Convention

Program complete for Oklahoma City meeting, October 11-13

STREAMLINED, no-red-tape registration will be available for members and guests attending the 19th annual meeting of the American Association of Oilwell Drilling Contractors, to be held in Oklahoma City on October 11-13.

A unique plan for advance pre-paid registration will permit early preparation of badges and arrangement for all facilities available to conferees and wives. The plan eliminates necessity of lengthy standing in line to register, reduces the amount of cash necessary during the convention for members, and reduces errors in registration.

Pre-planning on the part of the program committee has resulted in the early consummation of the convention schedule and committment of all principal speakers and technical paper presentations.

Top Speakers Slated

Among the top echelon government and industry leaders to address the 1000 expected to attend the AAODC convention are: Cameron Edmondson, Governor of Oklahoma; J. Ed Warren, president of Cities Service Company; Arthur Kline, commissioner of the Federal Power Commission; Chester Lauck, Continental Oil Company, and B. L. "Barney" Majewski, president of Great American Oil Company.

Program Schedule

On Sunday, October 11, registration will begin. A meeting of the board of directors is scheduled at 2 p.m.

Committee meetings are scheduled for Monday morning, beginning at 9:30 a.m.

First general meeting is the Monday luncheon. The group will hear Mayor James H. Norick of Oklahoma City, followed by the welcoming address by Governor Edmondson. Presentation of AAODC meritorious service awards will also be made at the luncheon.

Arthur Kline

Gov. Edmondson

J. Ed Warren

Barney Majewski

Chester Lauck

Warren Baker

The first general session will begin at 2 p.m. Monday, beginning with the president's address by Joe Zeppa. J. Ed Warren will address the membership, followed by a report of the nominating committee for new AAODC officers.

Tuesday's first general session will feature progress reports of major committees, and will include an address by John Woodruff, Petroleum Extension Service, University of Texas, speaking on development of vocational courses sponsored by the AAODC. Warren L. Baker, executive vice president of AAODC, will also speak to the group in general session Tuesday morning on the subject "Future Prospects for U. S. Drilling."

FPC views will be expressed by Arthur Kline, who will address the Tuesday luncheon group.

Technical Papers

Technical papers will be presented Tuesday afternoon. The subjects will be: "Use of Percussion Tools with Oil and Gas," "Effect of pH on Aerobic Corrosion Fatigue of Steel," "Effect of pH on Oxygen Corrosion at Elevated Pressures," and "Effect of Fluid Environment on Rock Bit Performance."

The convention will close with the annual banquet Tuesday evening. At that time newly-elected officers will be introduced. Toastmaster for the evening will be Chester Lauck, followed by the feature address by B. L. Majewski.

All meetings and registration will be conducted in Oklahoma City's Skirvin Hotel.

Housing Reservations

The association is now receiving advance registrations at its Dallas offices at 211 N. Ervay. The pre-paid fees ($28 for each registrant, no charge for wives) will be accepted until October 1. All registrations will be acknowledged by mail.

Housing reservations are being accepted by the housing committee chairman, AAODC, 200 Skirvin Tower, Oklahoma City, and will be confirmed on or before September 15.

Initial Cost is Less

... up to 35% *less*

with a

JOHNSTON

Hydraulic

PUMPING UNIT

When your wells go on artificial lift, install a Johnston Hydraulic Pumping Unit. Users report savings up to $2000 . . . up to 35% . . . over other pumping methods.

How? Add up these savings for yourself: no foundation required . . . unit price is lower . . . less installation time and cost . . . smaller rod string operation.

These are the savings you make on your initial investment with a Johnston Hydraulic Pumping Unit.

But that's not all. Because these are the smoothest running units in the field today, operators report less wear and tear on down-hole equipment and minimum maintenance. There is 100% salvage, too, if you wish to move your Johnston unit to another location.

Write today for complete information. There is a size to handle your particular application.

3ft Stroke **6ft Stroke** **9ft Stroke** **12ft Stroke**

Also available for dual and triple zone completions.

ENGINEERED OIL TOOLS, INC.

P. O. BOX 1665 1710 BURNETT ST. HOUSTON, TEXAS PHONE FA 3 0293

DISTRIBUTORS

DOMESTIC: Bovaird Supply Co.; Lacy Oil Tool Co., McJunkin Corp.; Production Equipment Products Co.; Union Supply Co.; Wilson Supply Co. CANADA: Canadian Well Services, Ltd. EXPORT: Wilson Supply Co., International Div.

9906

• Cuts cleanly with minimum flare.
• No damage to surrounding casing.
• Operates at pressures up to 10,000 psi.
• Operates at temperature of 300 degrees F.

Jet Tubing Cutter

Designed to answer the need for a dependable tool for removing bull plugs, tubing stops or other obstructions from the end of tubing strings, the Welex Jet Tubing Cutter cuts cleanly without damage to surrounding casing. Ideal for oil field salvage work and cutting stuck tubing, the Welex Jet Tubing Cutter is another service of the complete wireline service company.

ORIGINATORS OF Welex JET PERFORATING

WELEX, INC.

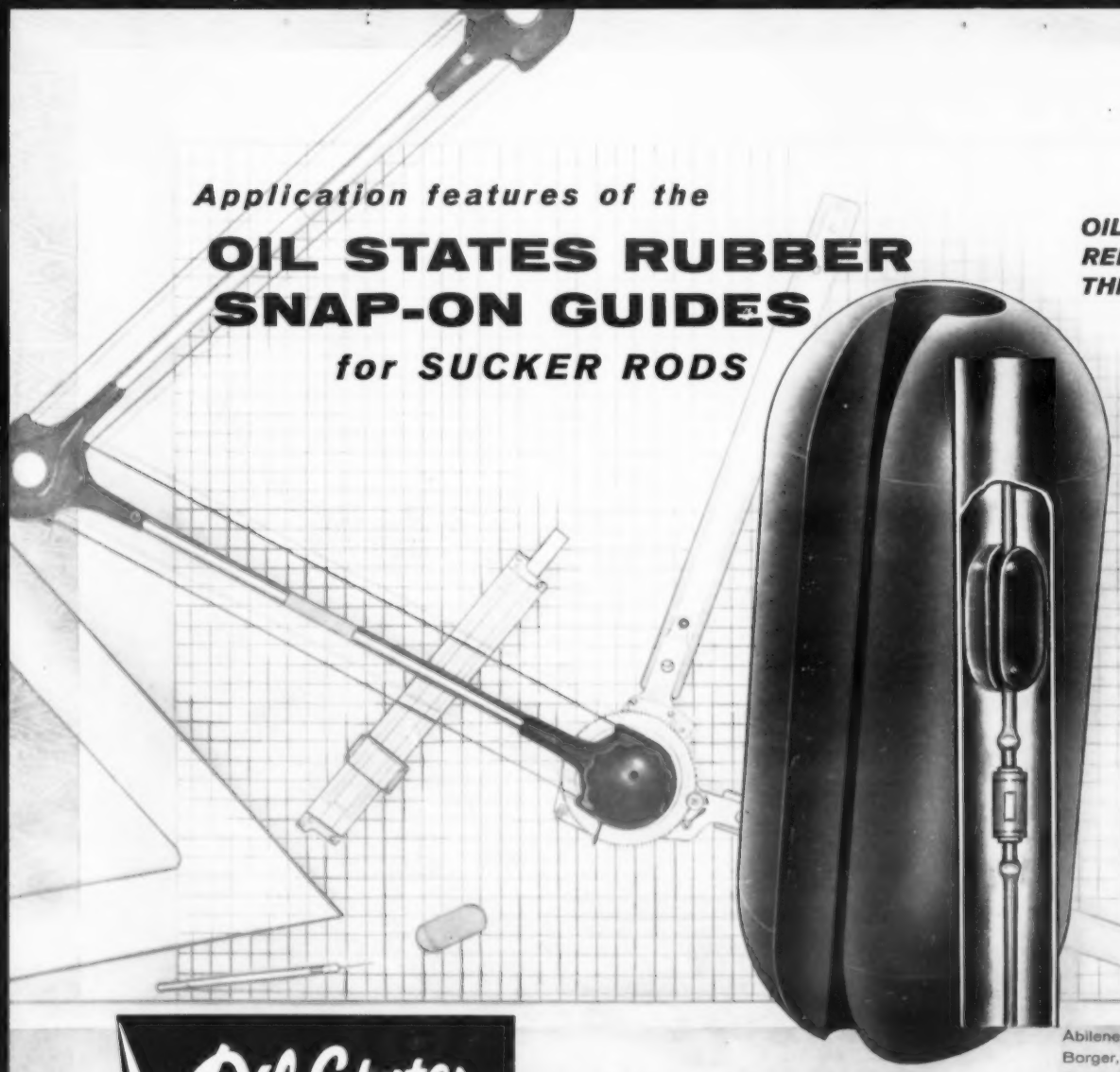
General Offices: 1400 East Berry, Fort Worth, Texas
Division offices in Denver, Houston, Los Angeles, Midland, New Orleans, Tulsa and Wichita.
District offices in every major oil center. Subsidiaries in Canada, Peru and Venezuela.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Application features of the

OIL STATES RUBBER SNAP-ON GUIDES

for SUCKER RODS



OIL STATES RUBBER SNAP-ON GUIDES REDUCE OPERATING COSTS THROUGH THESE APPLICATIONS--

- Used in crooked holes or directionally drilled wells, to minimize wear on rods and tubing.
- Prevention of metal-to-metal contact in ***any*** well, giving low-friction bearing surfaces, with less power needed to lift the same amount of fluid.
- Lessens wear on the pump, by installing several SNAP-ON GUIDES just above the pump to deaden rod whip.
- Installed closely spaced in paraffin deposit zones, so that the SNAP-ON GUIDES will overlap on the stroke length, preventing paraffin deposit build-up.
- To prevent wear on rods in wells with low polish rod loads on the downstroke, as when "plunger" pumps are used, by eliminating rod bending inside the tubing.

Sold Through Supply Stores Only

THE OIL STATES RUBBER SNAP-ON SUCKER ROD GUIDE
Patent No. 2,604,364

Contact your local OIL STATES Field Representative for analysis and recommendations for your particular well requirements. It costs you nothing for this professional analysis and it may save you thousands of dollars in rod replacements and service costs.

Oil States

LOCATION OF OIL STATES FIELD REPRESENTATIVES:

Abilene, Texas	Kilgore, Texas	Denver, Colorado
Borger, Texas	Odessa, Texas	Farmington, New Mexico
Corpus Christi, Texas	Wichita Falls, Texas	Great Bend, Kansas
Houston, Texas	Casper, Wyoming	Oklahoma City, Oklahoma

In Canada: Edmonton, Alberta

West Coast Distributor: Monarch Engineering Co. Gardena, California

"OIL FIELD RUBBER PRODUCTS OF MATCHLESS QUALITY"

OIL STATES RUBBER CO. • ARLINGTON, TEXAS • CR 5-0441

An Announcement

Hughes Tool Company can now announce the successful development of the first practical and effective bearing seal for a rock bit that seals in a bearing lubricant and seals out drilling and formation fluids.

The results, from a long series of field and laboratory tests, have demonstrated that these lubricated sealed bearings will substantially increase bearing life and the drilling life of the bit, where bearing life has been the limiting factor.

We now stand on the threshold of another series of Hughes developments that will lead to further important drilling economies.

The drilling industry can appreciate that the development of a successful bearing seal has been difficult and costly. There is still much to be learned before we can determine the full extent of its application to all sizes and types of bits.

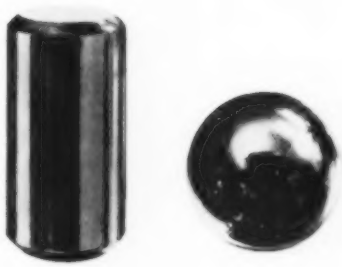
In developing the sealed bearings, we have, so far, largely concentrated on one size and on one type of the R Series insert bits. We concentrated on insert bits because we felt that the industry had the most to gain from extending the life of these bits in the hole . . . and by having them available in quantities at the earliest possible date.

A target date of January 1 has been set to have the first production sealed-bearing bits available for distribution in the type RG-1J, 8¾″ size. With regard to the other sizes in the insert series, and as to other types and sizes, distribution will be at the earliest date they can be produced, consistent with the Hughes policy of thoroughly testing each design before it is released to the field.

FRED W. AYERS
Senior Vice President and General Manager
Hughes Tool Company

40 HOURS

This ball and roller bearing were taken from a non-lubricated Hughes R-1 bit run 40 hours. They are representative of the bit's bearings.



75 HOURS

This ball and roller bearing were taken from a Hughes R-1 bit, equipped with sealed bearings, run 75 hours in the same field and under identical conditions as the 40-hour bit.

These photographs are unretouched. The irregular shadows you see in the bearings (above right) are the camera and lights reflected by the mirror-like surfaces of the bearings.

for FAST round trips...

ROILINE ENGINES
(Formerly LE ROI)

Roiline L-3460
7¼-in. bore x 7-in. stroke; 12-cyl. V-type;
speed range 600 to 1350 rpm; 640 max. hp.

Three ROILINE Model L-3460 Drilling Engines on a Brewster N-12 drawworks and an L. C. Moore 142-ft. mast—going strong at 9,849 ft. and bound for the 12,500 ft. Ellenberger Zone in the Permian Basin. With 4½-in. pipe, drilling superintendent Alford has pulled a 90-ft. treble stand in 40 seconds. He has averaged a treble stand a minute. These big ROILINES have the quick response, fast acceleration, and the reserve power to cut round trip time to a minimum.

Send for descriptive bulletins.

ARIZONA, Casa Grande, Engine Service Company, Inc.
CALIFORNIA, Long Beach, Engine & Equipment Company
COLORADO, Denver, Emrick & Hill Engine & Equipt. Co.
ILLINOIS, Centralia, John Nickell Company
KANSAS, Garden City, Carson Machine & Supply Co.
LOUISIANA, New Orleans, Southern Engine & Pump Co.
MICHIGAN, Reed City, Hafer Engine Company
OHIO, Columbus 19, Cantwell Machinery Company
OKLAHOMA, Oklahoma City 9, Carson Machine & Supply Co.
PENNSYLVANIA, Pittsburgh 34, P. C. McKenzie Company
TEXAS, Houston 1, Southern Engine & Pump Co. (also in Beaumont, Corpus Christi, Dallas, Edinburg, Kilgore, San Antonio)
Odessa, General Machine & Supply, Inc.
Wichita Falls, Nortex Engine & Equipment Co.
WYOMING, Casper, Emrick & Hill Engine & Equipt. Co.

444

• The trade mark LE ROI is used under license from Westinghouse Air Brake Co., the trade mark owner.

WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN / New York • Tulsa • Los Angeles
Factories: Waukesha, Wisconsin and Clinton, Iowa

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Petroleum Engineers To Hold 34th Annual Meeting In Dallas

MORE THAN 3,500 PETROLEUM ENGINEERS and their wives are expected to attend the 34th Annual Fall Meeting of the Society of Petroleum Engineers to be held in Dallas this year, October 4-7. Official meeting activities will be concentrated in the new Dallas Memorial Auditorium. The auditorium has been designated as a general headquarters, registration site, location of technical sessions and industrial exhibits; and it is here that the opening party, Bullwheel Barbecue, will be held on Monday evening.

Each engineer will be able to attend the presentation of technical papers pertaining to his professional field. Because of the large number — 67 different technical studies — and varied subject matters covered, there are two sessions or presentations scheduled at all times, and even three papers will be presented concurrently during a portion of the program.

The technical study presentations can be classified in eight general categories; oil recovery processes, well completions and treating economics — management — education, reservoir fluid and rock mechanics, drilling, reservoir engineering—pressure analyses, reservoir engineering — prediction methods, production operations, and logging.

Social activities include a welcoming luncheon, the previously mentioned Monday night party, ladies coffee, membership luncheon and ladies luncheon and style show. The highlight of the entertainment, a breakfast-dance, is planned for Tuesday night.

Dallas Local Section will host the meeting this year, with its chairman, Weldon Porter, Welex, as general chairman for the event. R. J. Bethancourt, Sun Oil Company, will serve as his administrative assistant.

Members directing the specific committees include Russell E. Lesser, British-American, arrangements; W. Frank West, Fred R. Oliver & Associates, entertainment; J. H. Sullivan, Atlantic, finance; Mrs. R. B. Gilmore, ladies activities; Jack Williamson, The Petroleum Engineer, publicity; K. W. Robbins, Otis, registration, and W. E. Hinchliffe, Halliburton, Transportation. ★ ★ ★

Los Angeles AIME Announces Fall Meeting

The 1959 annual fall meeting of the Society of Petroleum Engineers, Los Angeles Basin section, will be held at Pasadena's Huntington-Sheraton Hotel on October 22 and 23.

Viewed in petroleum circles as one of the industry's most significant technical forums, the meeting is expected to bring together more than a thousand engineers for the two-day conclave. They will hear twenty-six technical papers covering current problems in petroleum exploration, drilling, production and research.

An outstanding feature of the meeting will be a manufacturers' display of the latest equipment and service techniques developed for the finding and producing of oil. A number of the nation's largest oil equipment manufacturers now have elaborate "working" exhibits in preparation. ★ ★ ★

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

What's doing in DRILLING

— Photo Courtesy Jones & Laughlin Steel Corp.

Glamour of Hollywood movie sets surrounds this sound-proofed drilling rig that recently placed casing in the 27th well of Universal Consolidated Oil Company on the lot of 20th Century Fox Studios. Universal drilled its first well on the site in 1955. Here, Sun Drilling Company's crew is moving casing into the rig on Universal's Community 9-A well.

Reading & Bates New Rig Hit by Fire in Persian Gulf

Reading and Bates Offshore Drilling Company's new platform drilling rig was gutted by fire, less than 15 days after its first well had been spudded in the Persian Gulf. The rig, being operated by the Dutch-owned International Drilling Company, burst into flames August 4 when the crew encountered gas at a depth of 1500 ft.

The well, located 28 miles off the coast of Kuwait in the Neutral Zone, was under contract for the Japanese Arabian Oil Company. It was also the Japanese' first Middle East drilling venture.

At last report, the platform was still standing, although most drilling equipment has been lost.

President of the company, J. W. Bates, in Tulsa, Oklahoma, had just announced the spudding of the first well with the new rig on July 29.

Reading and Bates contract, according to Bates, was to run for a period of two years with International Drilling Company, starting with the spudding of the first well. Bates had estimated that the initial term of the contract would result in cash flow of more than $2,000,000.

Howell & Howell Stops Drilling at Oklahoma Deep Well

Grande Corporation, Howell & Howell, Gulf Oil Corporation, Tekoil Corporation, Kenneth A. Ellison and Associates, have temporarily abandoned their No. 1 Anadarko Basin, four miles southeast of Eakly, in Caddo County, Oklahoma.

The test, which had been featured in a *Petroleum Engineer* article last year, was engineered to a depth of 25,000 ft. Actual total depth of the well was 21,021 ft. A 7-in. liner was cemented at 21,010 ft. It had been spudded in November 1957.

In production attempts, following a series of deep hole difficulties, intervals at 15,144-556 ft, 16,268-525 ft, and at 20,917-921 ft were perforated and tested. The lower Bromide, one of the deeper objectives, was called at 20,937 ft.

The No. 1 Anadarko Basin is the second deepest well drilled in Oklahoma, surpassed by Shell's No. 5 Rumberger in the Elk City field, Beckham County. This well was abandoned at a depth of 24,002 ft.

Skid-Mounted Refinery To Fuel Drilling Rigs

A Houston, Texas, consulting engineer has proposed that contractors and operators drilling in remote areas utilize 500 to 1000 bbl per day skid-mounted refining units to cut fuel costs and eliminate many transportation problems.

On one project, Malcolm T. McCants suggested that an operator construct a 1500 bbl per day trailer mounted refinery to service its rigs in the Libyan Desert. The unit was designed to use a minimum amount of water, operating only at night, to convert lease oil into gasoline for small trucks, diesel oil for rigs and heavy trucks, and heavy fuel oil for roadbed stabilization.

The operator had been paying 50 cents a gal — or $6000 to $10,000 per day for its fuel costs, says McCants.

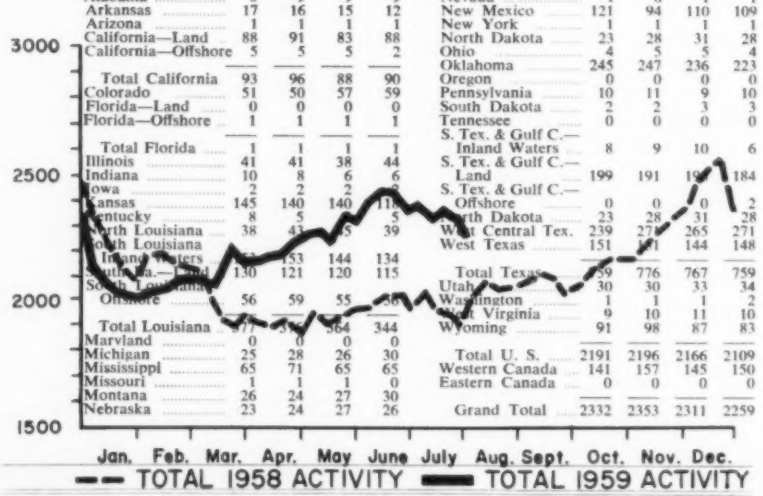
The refinery was described as completely thermal and required only two men to operate the unit per shift. Cost of the unit, crated at Houston, was $450,000 (less tankage).

McCants says the refineries can be modified to make asphalt or high octane gasoline, and can be constructed to run on high-sulfur crude, or to turn out a complete line of products.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.

	July 13	July 20	July 27	Aug. 3
Alabama	8	9	9	9
Arkansas	17	16	15	12
Arizona	1	1	1	1
California—Land	88	91	83	88
California—Offshore	5	5	5	2
Total California	93	96	88	90
Colorado	51	50	57	59
Florida—Land	0	0	0	0
Florida—Offshore	1	1	1	1
Total Florida	1	1	1	1
Illinois	41	41	38	44
Indiana	10	8	6	6
Iowa	2	2	2	2
Kansas	145	140	140	141
Kentucky	8	5	5	5
North Louisiana	38	43	45	39
South Louisiana				
Inland Waters		153	144	134
Southern La.—Land	130	121	120	115
South Louisiana Offshore	56	59	55	56
Total Louisiana	377	376	364	344
Marvland	0	0	0	0
Michigan	25	28	26	30
Mississippi	65	71	65	65
Missouri	1	1	1	0
Montana	26	24	27	30
Nebraska	23	24	27	26
Nevada	1	0	1	1
New Mexico	121	94	110	109
New York	1	1	1	1
North Dakota	23	28	31	28
Ohio	4	5	5	4
Oklahoma	245	247	236	223
Oregon	0	0	0	0
Pennsylvania	10	11	9	10
South Dakota	2	2	3	3
Tennessee	0	0	0	0
S. Tex. & Gulf C.— Inland Waters	8	9	10	6
S. Tex. & Gulf C.— Land	199	191	191	184
S. Tex. & Gulf C.— Offshore	0	0	0	2
North Dakota	23	28	31	28
West Central Tex.	239	274	265	271
West Texas	151	161	144	148
Total Texas	759	776	767	759
Utah	30	30	33	34
Washington	1	1	1	2
West Virginia	9	10	11	10
Wyoming	91	98	87	83
Total U. S.	2191	2196	2166	2109
Western Canada	141	157	145	150
Eastern Canada	0	0	0	0
Grand Total	2332	2353	2311	2259



Lee Brown Assets Sold

All physical assets of Lee Brown Drilling Contractor of Midland, Texas, have been purchased by Fain-Porter Drilling Company, Oklahoma City, through Lucey Products Corporation. Included in the transaction are three medium depth rigs, all equipped for high pressure drilling conditions existing in West Texas and New Mexico. All additional equipment stored in the company's Midland yard, including extra drill pipe and extra drill collars, were acquired.

The company's three rigs, two of them under contract, are located in Ector, Garza, and Gaines counties, Texas, and will be delivered on completion of present work.

Colorado O&G Disperses Navy Rigs

Drilling equipment purchased from the Navy at Point Barrow, Alaska, by Colorado Oil and Gas Corporation of Denver already is being dispersed to speed exploration of the vast sedimentary basins of Alaska. Surplus equipment, idle since 1953, included three large drilling rigs, 36,000 ft of drill pipe, 29,800 ft of casing, 1000 rock bits, and large quantities of spare parts and supplies. The competitive bid offer by Colorado for the equipment was approved by the government this month. Replacement value of the equipment is in excess of $4,000,000.

One of the rigs, capable of drilling to 15,000 ft, has been sold by Colorado to a group of independent operators headed by Paul G. Benedum. This equipment is being loaded now on barges at Point Barrow for shipment 1100 miles through the Bering Strait and up the Yukon River to Nulato. This is in the Koyukuk Basin of West Central Alaska where the Benedum group of 33 operators holds leases on 3,500,000 acres. The Benedum exploration well is projected to 12,000 ft.

Colorado will use one of the rigs capable of drilling to 8000 ft for its own operations on the North Slope. The third rig, equipped for drilling to 15,000 ft, will be offered to other operators in Alaska, where exploration for oil is mounting rapidly.

Colorado recently acquired 90,000 acres of leases north of the Brooks Range in Northern Alaska near the Naval Petroleum Reserve No. 4 The Colorado leasehold includes 10,000 acres on a known gas-producing structure at Gubik, about 400 miles north of Fairbanks. Colorado has moved to the Gubik area two drilling rigs formerly used by the Navy.

Sour Oil, Lodestone, Pressure,

Sand Cutting, Hydrogen Sulfide,

Ball Pounding, Salt Water Brine,

Magnetism, High Temperature,

Impact...Nothing Affects

That's right . . . with DuMore Balls and Seats, none of these conditions will cause a valve failure. DuMore is corrosion-proof to any known well fluid, and its metallurgical properties are surpassed only by the hardness and wearing qualities of tungsten carbide—the hardest metal in commercial use. A bargain at any price, DuMore costs only a little more than regular grade ball valves. Moreover, the expense of one pulling job alone will more than pay for fitting out a pump with DuMore Balls and Seats. • Try DuMore the next time you run a pump. You'll be more than satisfied with the service you'll get, and you'll like saving those pulling jobs, too! Ask your supply store about DuMore.

DuMore®

"Best Balls and Seats in the Oil Patch"

HF

HARBISON-FISCHER · FORT WORTH

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

FRANKS *Explorer* "Rocket"

CHECK FRANKS EXPLORER BEFORE YOU BUY

More Usable Power

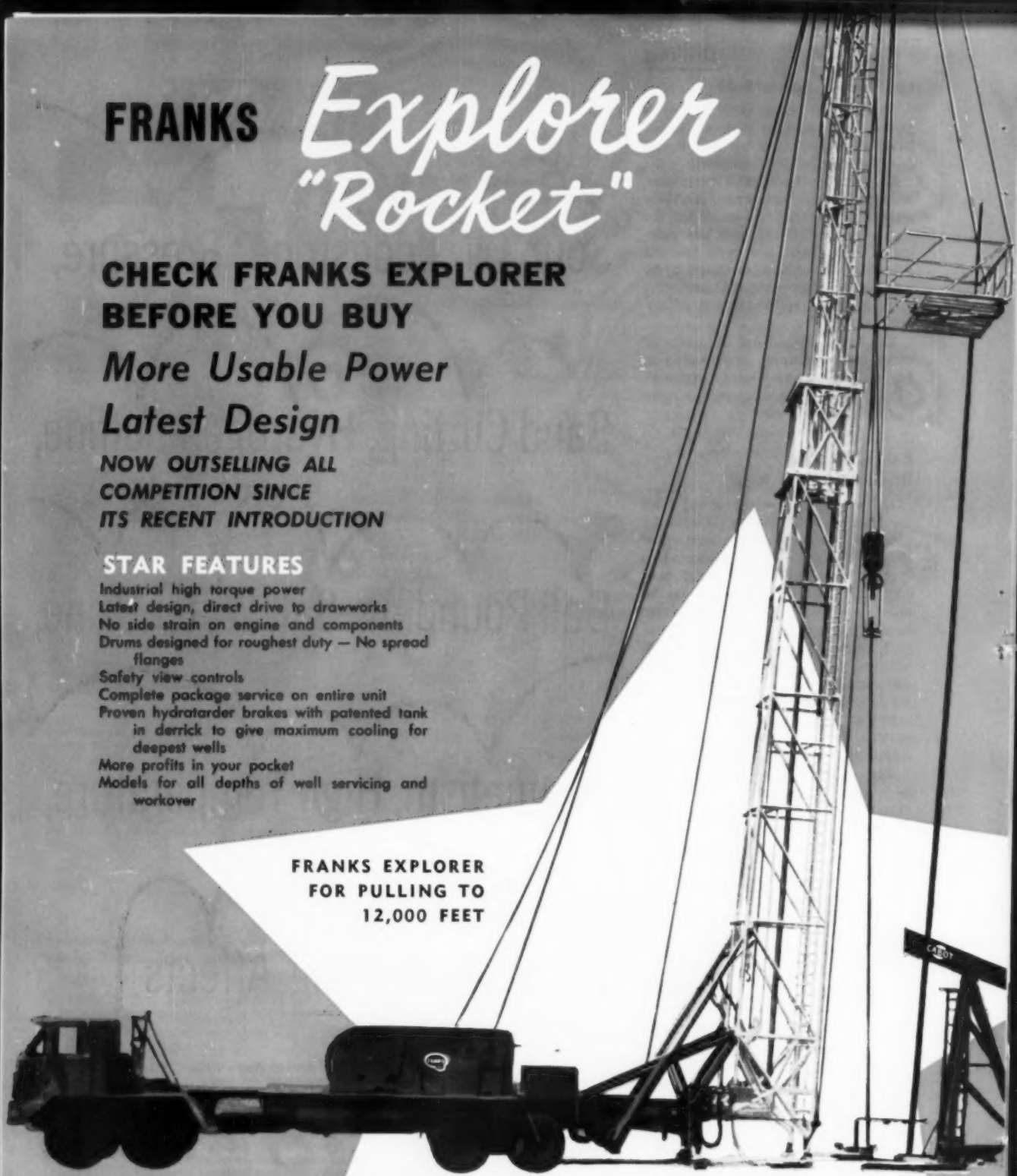
Latest Design

NOW OUTSELLING ALL COMPETITION SINCE ITS RECENT INTRODUCTION

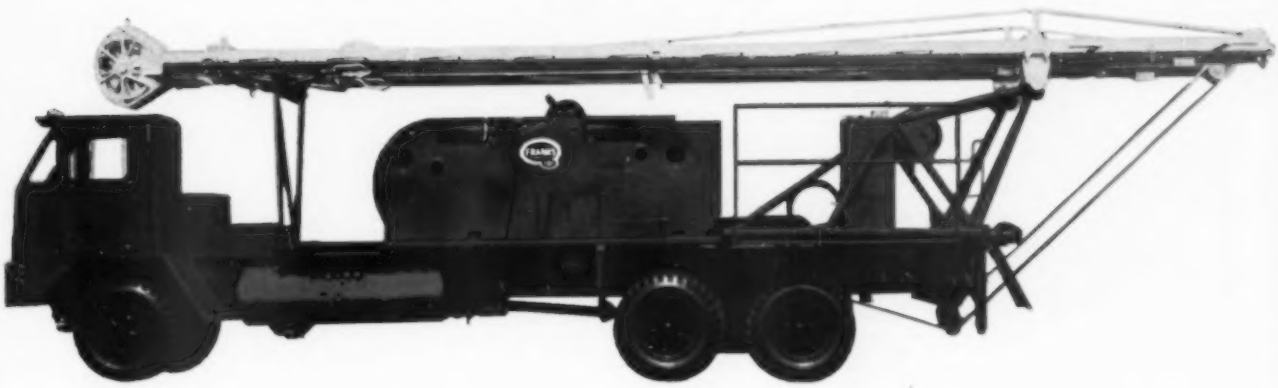
STAR FEATURES

- Industrial high torque power
- Latest design, direct drive to drawworks
- No side strain on engine and components
- Drums designed for roughest duty — No spread flanges
- Safety view controls
- Complete package service on entire unit
- Proven hydratarder brakes with patented tank in derrick to give maximum cooling for deepest wells
- More profits in your pocket
- Models for all depths of well servicing and workover

FRANKS EXPLORER FOR PULLING TO 12,000 FEET



Explorer "Cruiser"



STAR FEATURES

The most popular and widely accepted servicing unit in the field. Eight models, single or double pole masts. All balanced capacities to 12,000 feet.

- The pace setter . . . widely imitated but not duplicated
- New main drum design
- New hardened and removable brake rims
- New main drum brakes, water and air cooling system
- New power take-off oil bath chain drive
- Removable sand reel
- Full air clutches
- Single or double pole telescoping masts
- Hydraulic drive for power tongs and rotating workover heads

WELL SERVICING AND DRILLING UNITS

FRANKS

DIVISION OF

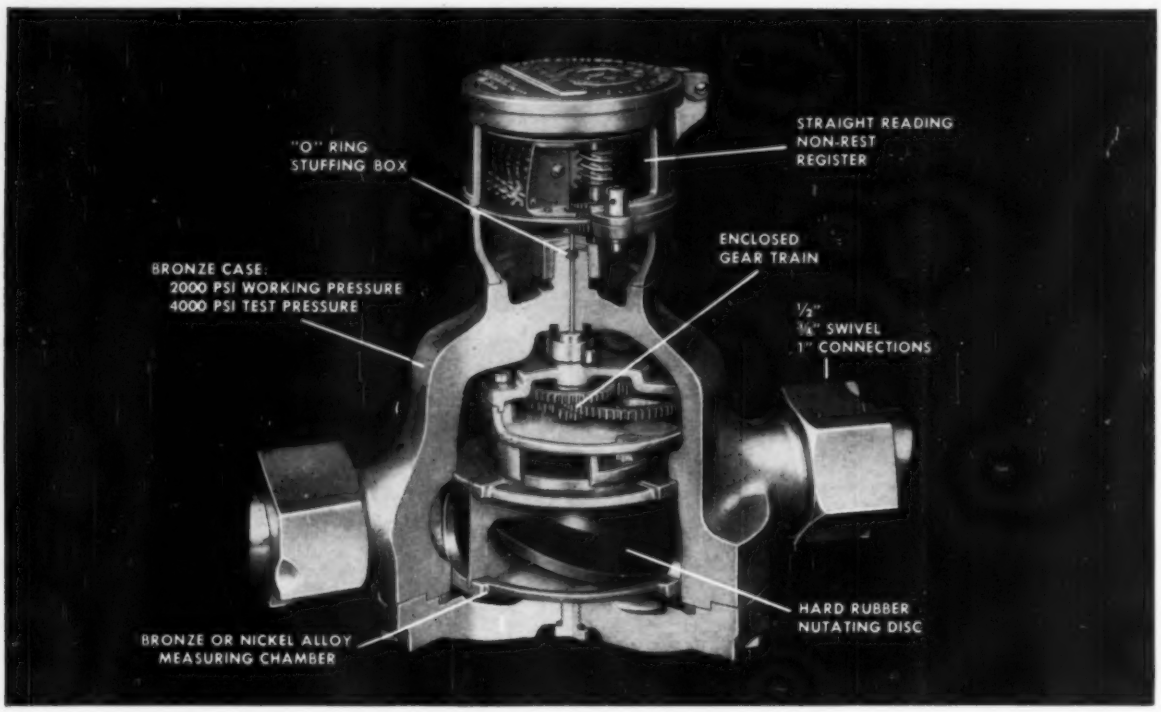
CABOT SHOPS, INC.

PAMPA, TEXAS

To assure additional safety!

4,000 psi TEST!

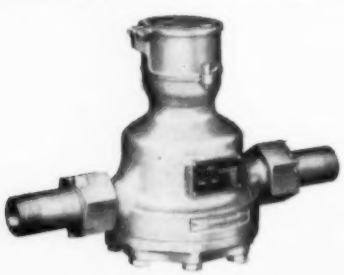
NEW ROCKWELL "504" FIVE POINTER METER



Meets the challenge of higher water flooding pressures

To measure and control the injection of water at today's higher flooding pressures, you need meters that will operate accurately without leaks or failures at working pressures to 2000 psi. The new Rockwell "504" will do just that with the added assurance of having been *tested at 4000 psi.*

Within this sturdy, bronze outer case you are offered a flexibility in materials to meet your service needs—the option of bronze *or* nickel alloy in chambers and gear trains for example. Optional coupling sizes of ½", ¾" and 1" simplify installation, while standardized laying length permits convenient interchangeability with present Rockwell Five Pointer meters. Complete details and specifications are given in Bulletin OG-353. Write Rockwell Manufacturing Company, Pittsburgh 8, Pa.



WATER FLOOD METERS

another fine product by

ROCKWELL

ORBIT VALVES

HAVE WIDE

APPLICATION IN WATER FLOODING SYSTEMS

You get a non-lubricated friction-free shut-off by using Orbit Valves — with no contamination from valve lubricants. Orbit Valves have full round straight thru unrestricted opening. For trouble-free performance, install Orbit Valves — they continue to operate easily even under the severest conditions encountered in water flooding service.

AVAILABLE IN SIZES: 1", 1½", 2", 2½", 3", and 4", 500 lbs. WOG thru 5,000 lbs. WOG.

USE ORBIT VALVES FOR SERVICES SUCH AS:

- INJECTION WELLS
- INJECTION WATER DISTRIBUTION MANIFOLDS
- PUMP DISCHARGE LINES
- FIELD LINES
- BRINE OR FRESH WATER

Write for Catalog 58-A covering Production Valves, 58-B covering ASA Class Valves.

ORBIT VALVE COMPANY
P. O. Box 699, TULSA, OKLAHOMA
PHONE LUther 4-4761 TWX TU 925

ORBIT VALVES®

RUNNING TOUR with MEN in the INDUSTRY

Boyd McCoy, Halliburton Oil Well Cementing Company, has been elected chairman of the New York section of Society of Petroleum Engineers of AIME, for the 1959-1560 term. Other officers will be **Latham L. Brundred,** American Climax Petroleum Corp., vice chairman; **Shannon L. Matheny Jr.,** Ideco, Inc., secretary; and **Fred A. Hilton,** Arabian American Oil Company, treasurer. Executive committee members include **William R. Waag,** Empire Trust Company; **Gerald E. Sherrod,** First National City Bank; **Larry E. Hess,** Socony Mobil Oil Company; and **Bryant C. Frihart,** Cities Service Oil Company.

Charles W. Hancock and Associates, Inc., newly organized as an independent firm to engage in oil and gas property management, has opened offices in Dallas, Texas. In addition to management services the firm will advise and direct administrative functions, and provide specialized engineering and technical assistance to producing firms operating in the Gulf Coast, Mid-Continent and Rocky Mountain areas. Hancock resigned July 31 as assistant to the division manager for Pure Oil Company's Southwestern producing division in order to establish the new organization.

H-G — NEW LEADER IN TUBING JOINT ENGINEERING FOR HIGH PRESSURE CONNECTIONS
TUBING JOINTS THAT SEAL TWO WAYS
with Metal-to-Metal Seal and a Compressed Soft Seal
Dual-Seal tubing connections* by Hardy-Griffin are the first field proved and accepted new design in over ten years.
Thread Seal
Teflon** Seal
Check these other features:
• 100% plastic coverage on all connections (a first)
• A complete range of joint types to handle shallow or deep, low or high pressure wells
• High joint efficiency
• Rugged design
• Low torque
• Streamline design
• Fast running
• Easy reconditioning
For the complete story, with technical data, write for the new Tubing Joint Handbook.
HARDY-GRIFFIN
ENGINEERING CORPORATION
A Division of Atlas Pipe Inc.
14522 South Main Street • Houston 25, Texas
Phone: GYpsy 9-9250
Odessa, Texas—Phone: EMerson 6-8241; Pampa, Texas—Phone: MOhawk 5-2411; Oklahoma City, Okla. — Phone: CEntral 2-6665; Tulsa, Okla.—Phone: Diamond 3-6791; New Iberia—Phone: EMerson 4-8666
*Pats. Pending
**DuPont's Tetrafluoroethylene Resin

C. W. Hancock

P. L. Versfelt Jr.

W. W. Yankie and **Angelo Chatas** announce the opening of a new office for their firm, Reservoir Analysts, in Tulsa, Oklahoma. **Porter L. Versfelt Jr.,** formerly research geologist with Alex McCoy, Associates in Tulsa, has joined Reservoir Analysts as chief geologist and manager of the Tulsa office.

Steve C. Maples announces the opening of his own offices as a consulting geologist at Okmulgee, Oklahoma. This terminates 15 years of service as a geologist for Sohio Petroleum Company in Oklahoma City, Pauls Valley, Midland, Texas and Okmulgee. The last four years he has worked in Sohio's Okmulgee area office as senior geologist.

Gilbert M. Andreen has joined Slick Secondary Recovery Corporation, San Antonio, Texas, as vice president in charge of production and engineering. For the past four years Andreen has been associated with the engineering and evaluation department of Core Laboratories, Inc., Dallas, where he served as senior supervising engineer.

G. M. Andreen

E. Hosford

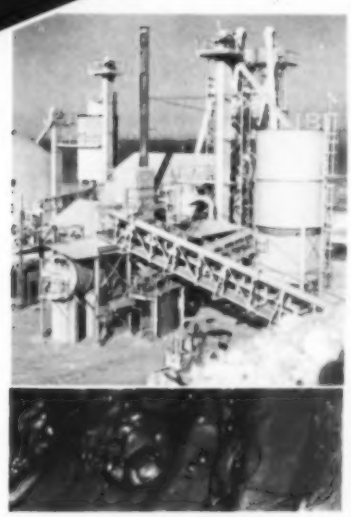
Eugene Hosford has been named operations coordinator for domestic production, Gulf Oil Corporation. He was transferred to Houston from Fort Worth where he has been division production coordinator. He succeeds **N. C. Simpson** who recently was elected an administrative vice president and coordinator.

Cities Service Oil Company's production division operations in Oklahoma named **D. S. Bodie,** district superintendent at Columbus, Texas, to assistant division superintendent in Oklahoma and transferred to Lindsay, Oklahoma, to assist in the early-stage organization of the Northeast Purdy unit. **C. T. Kemerling** of Odessa, Texas, moves to Lindsay as district clerk and **George L. Goodman** of Columbus is being transferred to Lindsay as production foreman. **J. W. Wise,** district superintendent in the Lindsay area will establish a new district production office in the Oklahoma National Bank Building at Chickasha. His enlarged district will include the Seminole and Walters areas and leases outside the Northeast Purdy unit in the Lindsay area. Wise's staff in the new Chickasha district will include **Charles L. Coffman** of Okla-

buy better... buy Baroid

from the highest grade mines ...your highest grade muds

Mines and mills like these—the finest in the mud industry—supply your yellow and red Baroid store. To get quality drilling mud quickly and efficiently get it from your Baroid store.



BAROID

BAROID DIVISION • NATIONAL LEAD COMPANY

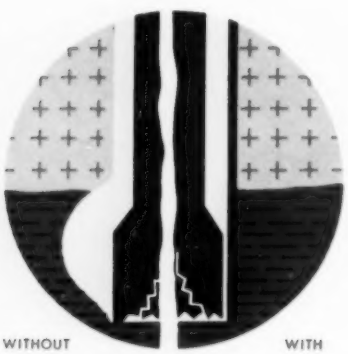
MAIN OFFICE: POST OFFICE BOX 1675 • HOUSTON 1, TEXAS

5909

Seeing is believing . . .

IMPERMEX*

controls *mud filtration properties*



LESS HOLE TROUBLE

PROTECTS PRODUCTIVE ZONES

BETTER CORES AND DST'S

Write for complete technical data bulletin on use of IMPERMEX.

IMPERMEX . . . successfully used for years to control mud filtrate loss.

IMPERMEX . . . controls mud filtrate loss in the presence of all drilled and make-up water contaminants.

IMPERMEX . . . allows better coring and easier drill stem testing.

BAROID

BAROID DIVISION NATIONAL LEAD COMPANY

MAIN OFFICE: P. O. BOX 1675, HOUSTON 1, TEXAS

*Registered Trademark, Baroid Division National Lead Co.

5908

homa City as district engineer, **John D. McCutchan** of Oklahoma City as petroleum engineer, **George E. Rose** of Lindsay as district clerk and **John B. McDade** of Norman as clerk.

Cities Service's Oklahoma City and North Oklahoma operations are being consolidated into the Oklahoma City district, with **R. L. Higginbottom** as superintendent for the enlarged district. **Hugh Riley** of Oklahoma City is division production superintendent for Cities Service in Oklahoma.

▸ **Henry H. Neel,** former Tidewater Oil Company exploration manager, has been appointed manager of foreign exploration and production for the company. **T. G. Kelliher** has been named manager of exploration, replacing Neel.

Neel was manager of foreign exploration and late in 1957, manager of exploration for the company. Kelliher was formerly manager of exploration for the southern division in Houston.

H. H. Neel

T. G. Kelliher

R. J. Bromell

R. L. Shick

▸ **Robert L. Shick,** formerly general superintendent of Tekoil Corporation, has been named to the new office of vice president and production manager. **Kenneth Davison,** who has been vice president in charge of operations, was named executive vice president.

▸ **Ray Bromell,** formerly with K. W. Davis Industries, has joined Jett Drilling Company, Inc., as assistant to the vice president. **Graham Land,** formerly with Texaco, Inc., was named head of the land department.

▸ Several personnel changes in Shell Oil Company's New Orleans exploration and production area management organization are: **E. J. McLain** named assistant to the vice president. **E. C. Abell,** formerly area land agent, succeeds McLain as manager of the land department. **Frederick J. Toth** has been named area production superintendent. Prior to his New Orleans assignment, Toth was division manager of Shell's Denver production division.

Shell has consolidated its various head office natural gas-gasoline activities into a new gas department. **W. B. Golush,** formerly manager of the head office gas department, has been named general gas manager. **J. T. Jordan,** formerly manager of the head office technological department, has been named manager-gas engineering in the gas department. **M. L. Newmaster,** formerly superintendent of Shell's TXL gasoline plant in West Texas, will serve as senior gas engineer in a gas utilization group.

▸ **Donald L. Horton,** Stillwater, Oklahoma, has assumed the new post of production engineer at Wichita, Kansas, for Northern Natural Gas Producing Company. He was associated with the Pan-American Petroleum Corporation at Pampa, Texas before joining Northern.

▸ **E. O. Buck,** senior vice president of The National Bank of Commerce in Houston, has been elected to the board of directors of Texas Petro Gas Company of Houston.

▸ Standard Oil Company of California announced the following changes in exploration department management: **E. H. Burtner** has been named assistant to the vice president, exploration, of Standard of Texas, with headquarters in Houston. **W. P. Winham** to assistant to the general manager, exploration, Western Operations, Inc., replacing Burtner. **M. W. Wolf** becomes division superintendent, great basin division, exploration department, replacing Winham. **E. G. Dobrick** to division superintendent, Pacific northwest division, exploration department, replacing Wolf. **J. E. McCall** named chief geophysicist, exploration department, replacing Dobrick. McCall has been superintendent, geophysics division, western region, of The California Company in Denver.

Only **SPANG** can give you the best in *Strength, Service, Economy and Footage* in a Prosser-type

SWIVEL ROPE SOCKET

There are times when an ordinary rope socket will meet your needs. But there are too many times when you can't afford to risk trouble—when you require a rope socket that's precision made and utterly dependable under all conditions. This is the time you'll be glad to have a Spang Rope Socket on the business end of your string—

. . . AND HERE'S WHY SPANG'S BEST

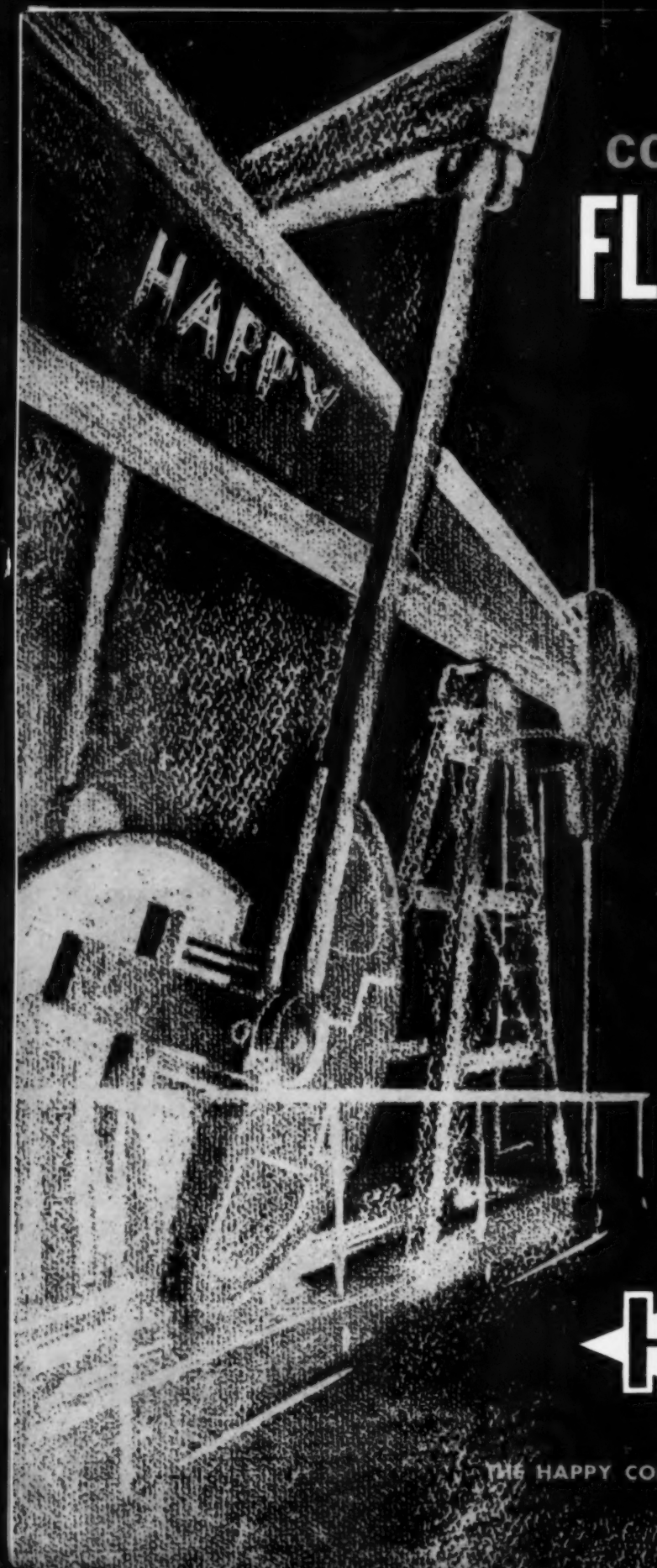
■ Completely Heat-Treated for maximum toughness and hardness ■ Precision machined ■ High steel strength ■ Extra strong joint ■ Carefully finished inside bore ■ Perfect setting for cable ■ Socket neck grooved for the use of fishing tools ■ Made by the country's oldest and largest manufacturer of cable tools

FIRST CHOICE OF DRILLERS EVERYWHERE

SPANG & COMPANY

DEPT. O-7 BUTLER, PENNSYLVANIA

For over 60 years Manufacturers of Spang Weldless Jars and a Complete Line of Cable System Drilling and Fishing Tools for Oil and Gas Wells, Water Wells, Prospect Drilling and Shot Blast Holes.



COLD CLIMATE FLEXIBILITY

There's never a freezing problem because Happy Flexdrive pumping units are ideally suited for colder climates. Only light oils are required for chain lubrication; no extreme pressure greases are needed. Lower horsepower is required to start and run a Happy Flexdrive unit — there's less friction loss.

Other Happy Flexdrive advantages include: rapid field adjustment; simple, safe, fast, one-man adjustable, removable safeTcranks; no-lubrication pitman heads; interchangeable oil-less type center, equalizer and wrist pin bearings; and fifteen-minute single point external chain tension adjustment.

HAPPY

THE HAPPY COMPANY • Box 770 • Tulsa 1, Oklahoma

Following "Frac Guide"...

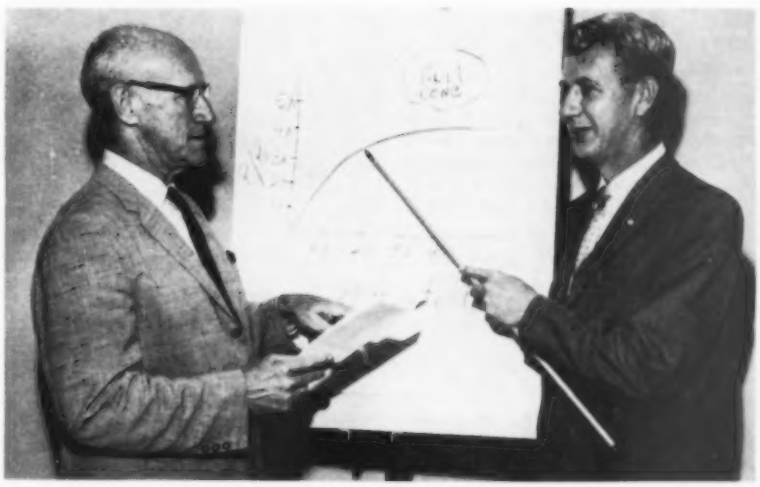
Acid Treatments Yield To Engineering Design

Service company introduces guide to engineered treatments, based on study of thousands of acid jobs

ANOTHER TECHNICAL AID for planning and predicting the effectiveness of oil well treatments has been disclosed by Dowell Division of The Dow Chemical Company. This new engineered technique is called the "Acid Guide."

Similar in scope to the recently released "Frac Guide," the "Acid Guide" was described at a technical meeting of petroleum engineers held in Tulsa recently. Complete information for field application of the technique was released to the company's district engineers at this meeting.

Based on detailed well and laboratory data, the guide offers several advantages to well operators. It is now possible to predict the advisability of an acid treatment for a specific well, on the basis of sound engineering principles rather than "trial and error." It also provides an engineering basis for predicting the probable production increase from a given acid treatment. Field results show a high degree of correlation with such predictions.



Acid (treatment) comments are exchanged by Dr. W. W. Love, Dowell's director of research, Tulsa, and R. E. Hurst, Dowell's district engineer, Midland, Texas, shown here at the recent technical meeting for petroleum engineers in Tulsa.

Helps Choose Acid

Some of the factors that have a direct bearing on the cost of an acid treatment and the results obtained have been hard to evaluate. Chemical research has made so many acid mixtures available that selection of the proper one has become somewhat difficult. For example, the guide now makes it possible to determine the best type of acid to use in an oil producing formation, its proper concentration and the right amount to secure optimum results.

The distance acid penetrates into the oil reservoir before it is spent is controlled by the type of acid and by the injection rate. For example, regular acid is used up in a relatively short time. Other acids, such as those containing retarders, require longer contact with the reservoir rock before they are used up. Also, the rate of injection determines the amount of acid penetration before spending; a high rate of injection would naturally give greater penetration. However, the rate of injection is controlled by the pressures limitation of the well equipment and the economics of the horsepower available to the operator.

Sets Treatment Requirements

The guide provides a means of balancing the kind and volume of acid against the injection rate to secure optimum penetration into the reservoir. Field results have shown that when this balance is not achieved either a too small or a too large volume of acid may be used. For example, the guide shows that for a given kind of acid and injection rate, only a certain degree of penetration into the rock can be achieved, no matter how great a volume of acid is used. This means that some acid treatments made in the past probably have been much larger than necessary to secure optimum results.

The manual is based on a series of curves derived from a detailed study of thousands of acid treatments made on many kinds of wells and in many reservoirs. The starting point in planning an individual acid treatment is the determination of an acid index number. This index number varies from well to well and is obtained from laboratory analyses of well samples and other reservoir data including bottom pressure and temperature. Other factors to be evaluated in planning an acid treatment are type of drilling fluid used in drilling the pay, degree of bore hole damage and type of reservoir fluid. Formation breakdown pressure, depth to pay, number and thickness of producing zones and completion method also must be considered.

The guide was developed through the coordinated efforts of company engineers in West Texas and scientists in the research laboratory in Tulsa.

The first treatment engineered with the aid of the guide was performed more than a year ago. Since that time the guide has undergone continuous revision and improvement. Research to improve the guide further is continuing both in the field and in the company laboratories, officials said.

Copies of the "Acid Guide" have been distributed to all Dowell service engineers for use in preplanning acid treatments. ★ ★ ★

EXPLORATION ACTIVITIES

AUSTRALIA

Magellan Begins Airborne Survey

An airborne magnetometer survey has begun on 30,000 sq miles of concessions held by Magellan Petroleum Corporation in south-central Queensland. The work on the Magellan properties is being carried out by Aero Service Corporation of Philadelphia, which operates from bases at Charleville and Longreach in north central Queensland.

In addition to the aerial magnetometer survey of this area, Magellan has begun gravity meter studies of another concession of 3,200,000 acres near Winton, also in Queensland.

Both of Magellan's concessions in Australia lie within the Great Artesian Basin, one of the largest known geological provinces. Most of the area of this basin now is held under concession by major oil companies and independents and exploration has increased materially since a recent discovery near Papua by Standard Vacuum Oil Company. Delhi-Taylor's subsidiary, Delhi Australian Petroleum Ltd., is currently drilling a 14,000-ft wildcat in Queensland, the first of three wildcats to be drilled in a 2-year period in a joint venture with Santos and Frome Broken Hill Pty., Ltd.

To date, fewer than 50 test wells have been drilled in Australia to a depth sufficient to reach possible oil-producing horizons, a fact which is highly significant in view of the size of the country. In the event of a discovery, Australia enjoys a unique position since it has an internal consumption of 220,000 bbl of oil daily, all of which is imported from the Near and Far East and South America.

ARIZONA

New Four Corners Mississippian Discovery

A successful wildcat in the Four Corners area of Arizona was announced by Texas Pacific Coal and Oil Company, with the completion of the Navajo Tract 138 No. 1.

The new well was completed in the Mississippian from perforations at 5566-5589 ft, and potentialed on pump at 240 bbl of oil and 27 bbl of water in a 24-hr period.

The discovery well is 8 miles south of the nearest production in the Pennsylvanian in the Boundary Butte field.

Located in the northeast quarter of Sec. 11, T40n, R28e, in Apache County, the well is in the center of a 2357-acre tract owned jointly by Texas Pacific, Monsanto Chemical Company, The Pure Oil Company and Sun Oil Company. Texas Pacific is operator.

Texas Pacific also holds a third interest in another four-section tract 15 miles west, and a half interest in a similar block a few miles south of the discovery well.

UTAH

Stancal Indicates Oil Find in Duchesne County

Discovery of a new oil field in Duchesne County, Utah, 16 miles northwest of the town of Roosevelt, has been made by Standard Oil Company of California, Western Operations, Inc.

Tests indicated the discovery well has an initial capacity of more than 350 bbl daily. Production is from Eocene sands, in three intervals between 10,000 and 12,000 ft.

Located on the Uintah and Ouray Indian Reservation, the discovery is the third well drilled by Standard on this prospect and the first productive well completed on the north side of the Uintah Basin. The company has 60,000 acres under lease in the area.

LOUISIANA

Offshore 'Cat Shakes Storm, Completes 8-Pay Discovery

Pan American Petroleum Corporation has successfully drillstem tested a Louisiana gas wildcat 45 miles offshore in Block 176 field in the Ship Shoal area.

Pan American - Texaco No. 1 OCS 0590, a mile east of nearest production in the field, flowed at the rate of 3000 Mcf of gas per day on a 16/64-in. choke, from perforations at 6814–26 ft, on a two-hour test. Tubing pressure was 2000 psi and shut in pressure was 2600 psi. Gas-oil ratio was 93,000 to 1.

The operator indicated that eight possible gas pay zones were successfully tested from 4170 to 6900 ft, with 142 ft total net gas pay sands. Total depth of the well is 10,205 ft.

Drilled in 97 ft of water, the Pan American - Texaco wildcat is on a 5000 acre lease for which a bonus of more than $1,250,000 was paid.

Pan American indicated that high waters from Hurricane Debra has delayed completion operations, scheduled to begin as soon as high waters subside. The well will be shut in.

Pan American Petroleum Corporation and Texaco, Inc., each have 50 percent interest in the well.

Multi-Zone Gas Discovery Indicated Near Block 208 Dome

Pan American Petroleum Corporation has discovered a new gas field in the Gulf of Mexico with the completion of the company's farthest-offshore well, more than 55 miles from Horseshoe Bayou, St. Mary's Parish, on the west flank of Block 208 Dome in Block 207 in the Eugene Island area.

Pan American's OCS 0575 No. 1 was drilled in 95 ft of water on a 2500-acre block for which Pan American and Texaco, Inc., equal holders, paid $3,250,475.

Completed from perforations at 12,-552-60 ft in the Pliocene, the well tested at the rate of 1,200,000 cu ft of gas per day and 80 bbl of distillate on an 11/64-in. choke, with a gas-oil ratio of 15,000 to 1. Flowing tubing pressure was 4200 psi, with shut-in tubing pressure of 5900 psi.

Several other possible producing sands were indicated by the well, Pan American spokesmen said. CATCO Group has obtained previous production in the block, all from shallower pay zones. In addition to the block on which the completion is located, Pan American and Texaco have equal interest in two other 5000-acre blocks in the vicinity.

The OCS 0575 No. 1 was shut in following completion, and the drilling rig moved three miles farther seaward to prepare for spudding of a 10,200 ft test of the north flank of Block 198 field on Block 177, on a third 5000-acre block held jointly by Pan American and Texaco.

Offshore Drilling Company was contractor for the discovery.

Cockfield Production Found In Opelousas Field Area

An important Louisiana wildcat discovery has been finaled by Tidewater Oil Company one and one half miles south of the Opelousas field in St. Landry Parish, with the completion of Tidewater's No. 1 Elena Jennings as a rich dual gas-condensate well.

The No. 1 Jennings is producing from two Cockfield sands, three miles southwest of nearest previous Cockfield production in the Poplar Grove field. Opelousas field production is from the Sparta.

The upper zone, perforated from 10,670–72 ft in the Cockfield No. 2, produced at the rate of 2530 Mcf of gas daily on a 9/64-in. choke with a yield of 84 bbl of 51 deg condensate

Again, Core Lab research rings the technological bell!

For the first time since the advent of gas chromatography in mud logging, here is an electronic system that answers all field requirements.

Simple in design and operating principle, the new and versatile **P**rogrammed **H**ydrocarbon **D**etector provides super-sensitive detection and analysis of *total* gas. Not simply one, or two, or three hydrocarbon components but *all* fractions present — including the heavies. And you can monitor the components in rapid-fire sequence — either singly or in various combinations.

P/H/D, utilizing a Core Lab-conceived "back flush" technique, automatically analyzes and records methane only, plus heaviers, in 90 seconds; methane and ethane individually, plus heaviers, in 120 seconds; methane, ethane, and propane individually, plus heaviers, in 180 seconds; etc. The range from methane through pentanes can be completed in six minutes!

A *single* continuous recording is cleaner and sharper with taller peaks — making the heretofore "lost" heavier hydrocarbons easy to discern.

P/H/D is built the way rig-side service equipment should be built — sturdy, compact, and with no complex maintenance problems.

P/H/D is not merely an untested drawing-board project. It's ready *now* to help you find more oil.

Play it smart. Call Core Lab. (Ask for descriptive literature.)

PATENTS APPLIED FOR

CORE LABORATORIES, INC.

BOX 10185 DALLAS 7 TEXAS USA • CABLE ADDRESS CORELAB

CORE LAB

DALLAS FT WORTH HOUSTON TYLER EL DORADO MIDLAND ABILENE PAMPA AMARILLO MONAHANS LUBBOCK HOBBS PECOS ROSWELL CORPUS CHRISTI VICTORIA McALLEN SAN ANTONIO SHREVEPORT TULSA OKLAHOMA CITY WICHITA FALLS BARTLESVILLE WICHITA LIBERAL LAFAYETTE HATTIESBURG JACKSON NEW ORLEANS DENVER STERLING CRAIG CASPER WORLAND KIMBALL WILLISTON FARMINGTON LOS ANGELES BAKERSFIELD LONG BEACH CALGARY EDMONTON REGINA ARGENTINA COLOMBIA VENEZUELA

per million. Flowing tubing pressure was 4800 psi.

The No. 1 Jennings' lower pay zone in the Cockfield No. 3-A produced at the rate of 1450 Mcf per day from perforations at 10,876–84 ft on a 14/64-in. choke. Condensate yield was 58 bbl of 51.8 deg per million. Flowing tubing pressure was 2575 psi. Tidewater also reported a highly successful test in the shallower Cockfield No. 1.

The operator is presently staking location for a second well, the Elena Jennings No. 2, one half mile southwest of the No. 1 Jennings.

Texaco Completes 280 Bbl Flanker in Parcperdue Field

Texaco Inc., announced the Leonie Hebert No. 1, Sec 34, 11s, 4e, in Vermillion Parish, was completed as a successful confirmation test 1600 ft west of the discovery well in Parcperdue field.

The well flowed at the rate of 280 bbl daily of 40.3 deg oil from perforations at 13,266-80 ft through a 6/64th-in. choke with 7850 psi tubing pressure. Gas-oil ratio was 2300 to 1.

ARGENTINA

Rig Winterized For August Test

Union Oil Company of California will begin drilling its first exploratory well in Argentina with the arrival of a shipload of drilling equipment which is en route today to the tiny port of Puerto Deseado, 1000 miles south of Buenos Aires, the company announced today.

Union Oil has 27-year contract for exclusive exploration and development of two parcels totaling 4,000,000 acres in the provinces of Chabut and Santa Cruz.

Due to the proximity of the drill site to the Antarctic Circle, the Santa Fe Drilling Company which has contracted for the job, fully winterized the rig for year around operation.

TEXAS

Tex Am Completes Flowing Strawn 'Cat

Texas American Oil Corporation, et al No. 1 Girard Trust is a new flowing Strawn discovery in Kent County.

The well flowed 170 bbl of new oil in 8 hours on a 24/64-in. choke for a calculated daily flow of 510 bbl; flowing pressure was 170 psi. The well is producing from perforations between 6574-6580 ft and 6586-6596 ft.

The new discovery is 542 ft from the west line and 392 ft from the south line of Section 35, Block 1, H&GN RR. Co. Survey. The new discovery well is on a 720 acre lease.

Gas Discovery Testing In Hansford County

Drilling and Exploration Company, Inc., et al., have an indicated gas discovery in southwest Hansford County. The No. 1 Murphy — Bundy, was drilled to a total depth of 7000 ft in the Mississippian formation. It was plugged back to 5050 ft; 5½-in. casing was cemented at 4950 ft and through a 12/64-in. choke the well tested, without artificial stimulation, 1,400,000 cu ft of gas per day through perforations from 4811 to 4819 ft in the Douglas sand. Testing continues.

The test is located on a drilling unit, owned 50 percent by Drilexco, containing all of Section 1, Block 46, P. W. Henderson Survey and Sections 5 and 6 of Block 3, G. H. and H. Survey. The well is southwest 2½ miles from the Drilexco No. 1 Cator, a Morrow sand discovery completed in March 1959.

Try for New Oil Set on Boling Dome

A 7800 ft exploratory Frio and Margulina test has been spudded by Trice Production Company's Texas Gulf Coast District, one half mile east of Boling, in Wharton County.

Trice Production Company No. 1 Mildred Gary is located about 1000 ft east of production on the Boling Dome. The location is spotted 281 ft north of the south line and 710 ft east of the west line of the 72.34 acre Mildred Gary tract in the Stephen F. Austin League, Abstract 2.

AFRICA

New Syndicate Plans Exploration in Southwest Africa

Trans-American Mining Corporation, Ltd., has been granted an oil and gas concession covering 10,000 sq miles in the west central area of Southwest Africa — the first in that region.

Trans-American Mining, a Canadian mining development company, will manage the operation on behalf of an American syndicate composed of Charles Payson, Julius Fleischmann, Richard Cowell, Winston Guest and the Waterford Oil Company.

Chief geologist will be J. C. Christensen, former head of the exploration and concessions group in the oil and mineral department of Getty Oil Enterprises. He was also formerly manager of their Middle-East oil operations.

Plans call for an immediate aerial and gravity meter survey of the Namid Desert sedimentary basin, where the new concession is located, to determine depth of the sediments in this area.

The Namid Desert basin is in the only unexplored one of the five great sedimentary basins that lie along Africa's west shore, between the Gold Coast and the tip of the continent. Maps indicate that this sedimentary basin has a tertiary age surface, the thickness of whose sediments is unknown.

The nearest oil discovery is 1000 miles away in Portuguese Angola and consists of three large fields which were brought in four years ago by a Portuguese company working with Petrofina, the Belgian oil company.

The concession is located in a thinly populated area in one of the least-known and wildest parts of the West African coast. The area is known as Diamond Mining Area No. 2; gem and industrial diamonds are being mined along the coast by Diamond Mining and Utility Company (S.W.A.) Ltd.

LIBYA

New BP Test Well To Spud in Cyrenaica

Deepest test well yet to be drilled in Libya for BP Exploration Company is to be spudded-in in mid-October. It will be the first well to be drilled in BP's concession area in Cyrenaica, some 200 miles south of Tobruk and the same distance from the Egyptian frontier.

Equipment capable of drilling to a depth of 12,000 ft will be taken by truck from Tripoli along mine-cleared tracks. The site is in the middle of a gravel plain entirely uninhabited. The 22 members of the drilling team who will spend eight or nine months on the site will be supplied by aircraft.

BP Exploration Company has previously drilled three test wells in Libya, in which it has more than 70,000 sq kilometres of concessions.

Esso 'Cat Flows 17,500 BD; Brings New Rig Into Area

Esso Standard (Libya) Inc., affiliate of Jersey Standard, has advised the Libyan government of plans to bring in another drilling rig to delineate its prolific new Zelten discovery.

Completion of its wildcat in the Cyrenaica province, producing at the rate of 17,500 bbl per day, was announced in mid-April. The company had drilled three previous dry holes on its Concession Number Six in that area. The well is 100 miles from the Mediterranean Coast and 200 miles south of Benghazi.

In a production test Zelten No. 1 produced oil at a rate of 17,500 bbl per day. The well was brought in and tested for 12 hours on June 11. Production is from a limestone section between the depth of 5460 and 5665 ft. The oil is of 37 deg API gravity.

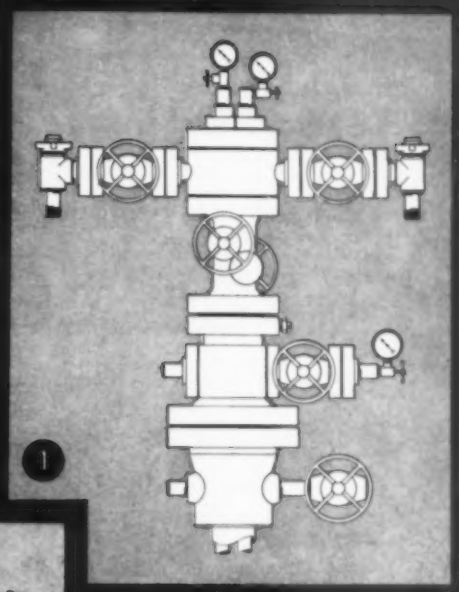
4 Gulfco Dual String Assemblies

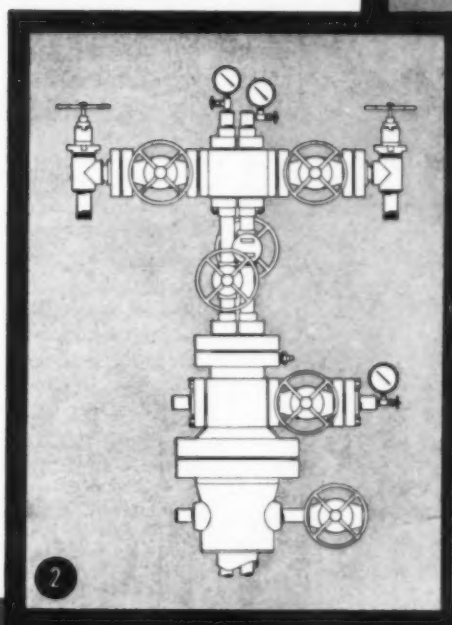
1. Gulfco DMH tubing assembly with separate threaded hangers and integral block master valve. For **highest** pressure and **deepest** wells.

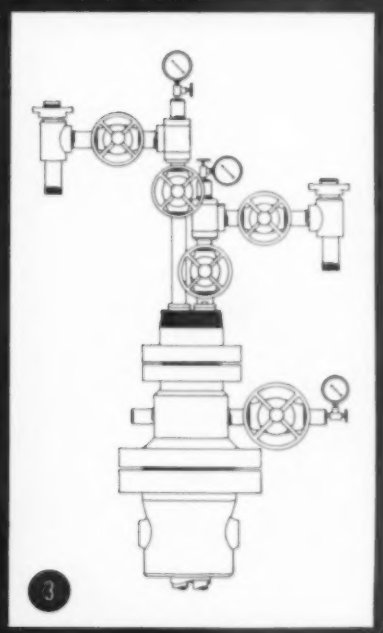
2. Gulfco DMH tubing assembly with individual flanged master valve. For **high** pressure and **deep** wells.

3. Gulfco DCM tubing hanger with individual screwed master valve. (Hangers can be furnished with slips or mandrels.) For **medium** pressure and depth.

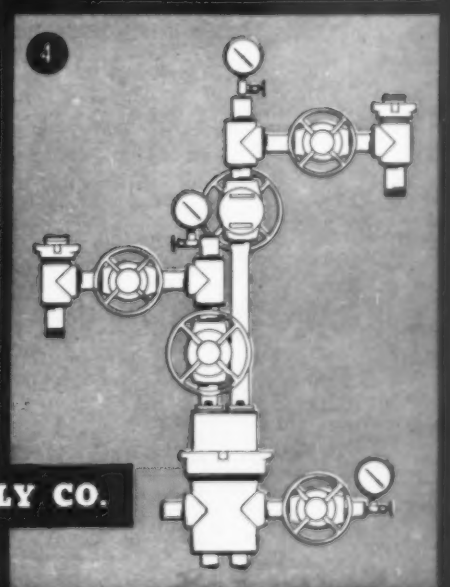
4. Gulfco FW-DCM tubing hanger with individual screwed master valve. (Hangers can be furnished with slips or mandrels.) For **medium** pressure and depth.







GULFCO FOR LOW TO HIGH PRESSURES AND SHALLOW TO DEEP WELLS



GET THE COMPLETE STORY TODAY

Whatever your dual completion problem, Gulfco has a tubinghead body and hanger engineered to do the job. You'll get experienced, friendly suggestions when you consult your Gulfco representative. Give him a call today.

Go With GULFCO In '59

GULF COAST MACHINE & SUPPLY CO. GULFCO TRADE MARK PRODUCTS BEAUMONT, TEXAS

ASSOCIATION OF WELL HEAD EQUIPMENT MANUFACTURERS CERTIFIED

GULF COAST MACHINE & SUPPLY CO.

BEAUMONT, TEXAS

To save time . . .
Every Tool Box Needs
a compact, easy-to-carry

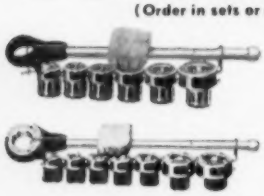
RIDGID®

Drop Head Threader Set

Snap a die head in the ratchet ring . . . cut your thread! It's as simple as that with a RIDGID drop head threader. Heads can't fall out . . . dies reverse quickly for close-to-wall threading. Finest quality RIDGID long wearing dies. Conduit dies available.

Call Your Supply House!

Hand Carrier Free With All Sets Except No. 12-R
(Order in sets or any combination)



Exposed Ratchet Type
For pipe—⅛" to 1"—00-R
⅛" to 1¼"—111-R
⅛" to 2"—12-R
For bolts—¼" to 1"—00-RB

Enclosed Ratchet Type
For pipe—⅛" to 1"—0-R
⅛" to 1¼"—11-R

RIDGID®
The Ridge Tool Company · Elyria, Ohio, U.S.A.

COED RECEIVES PE DEGREE

JANE E. DEAN, 21, University of Texas student from Fort Worth, is the first girl to receive a bachelor of science degree in petroleum engineering from the University.

She completed her degree requirements August 20 at the close of the summer session.

Dr. George H. Fancher, petroleum engineering department chairman, said about 12 girls have enrolled in petroleum engineering, but Miss Dean was the first one who persevered." The others either got an "MRS." or degrees in other fields.

When Miss Dean first walked in his office in 1955, Dr. Fancher said he surmised, "She's too pretty to last." But she proved to be an "excellent student" and has "done what most boys don't do." She got two degrees — her first was a bachelor of arts in mathematics.

Miss Dean didn't think it would be unusual to study petroleum engineering in college, until she discovered she was the only girl in most of her classes. As the daughter of Paul C. Dean, Fort Worth independent oil operator, she grew up in the oil business.

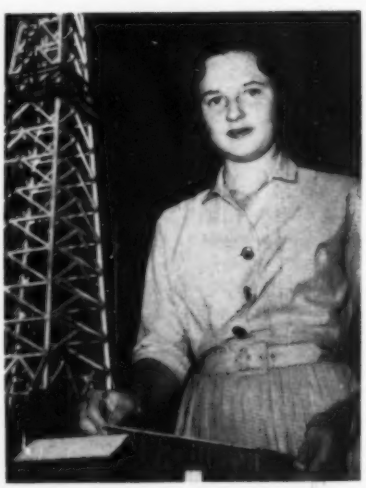
"I like petroleum engineering," she emphasized. "I'm not trying to accomplish anything unusual. I certainly didn't choose petroleum engineering with the idea of crusading for women in a man's field."

Miss Dean recently began working in her father's offices in Fort Worth. Her job will be to study and evaluate field data on oil reservoirs and to propose methods of secondary recovery — particularly where waterflooding would be most successful in forcing out the hidden oil.

"Obtaining a job with a major oil company would be difficult, except perhaps in research," she said. "And I realize field work for a girl would be definitely impossible."

In petroleum engineering classes, the young men had the advantage of first-hand knowledge because they spent summers working in the oil fields, Miss Dean recalled. But she said all her fellow students, as well as the professors, were "exceedingly patient and helpful."

Miss Dean, a 1957 Fort Worth debutante, is a graduate of Paschal High School. She is a junior member of the American Institute of Mining, Metallurgical and Petroleum Engineers, and a member of Pi Beta Phi social sorority.



Jane E. Dean, the girl a University of Texas professor considered "too pretty to last" through four rough years of studying petroleum engineering, is the first coed to graduate from the University with a bachelor of science degree in that field.

NOW—A REVOLUTIONARY APPLICATION OF HYDRAULIC POWER

WESTERN'S SANDRIL PROCESS

Versatile new method of—

* **Controlled penetration in casing perforating**
* **Controlled penetration in open-hole perforating**
* **Shoot and treat on same set-up**
* **Shoot and test on same set-up**
* **Assured penetration through contaminated zone**
* **Permanent completion**
* **Natural completion with no treatment**
* **Any application requiring deep penetration into matrix**

Sandril is the Western-developed process that utilizes hydraulic power and an abrasive sand-fluid mixture as a highly effective method for perforating casing, cement and/or formation with controlled penetration — measured in feet instead of inches.

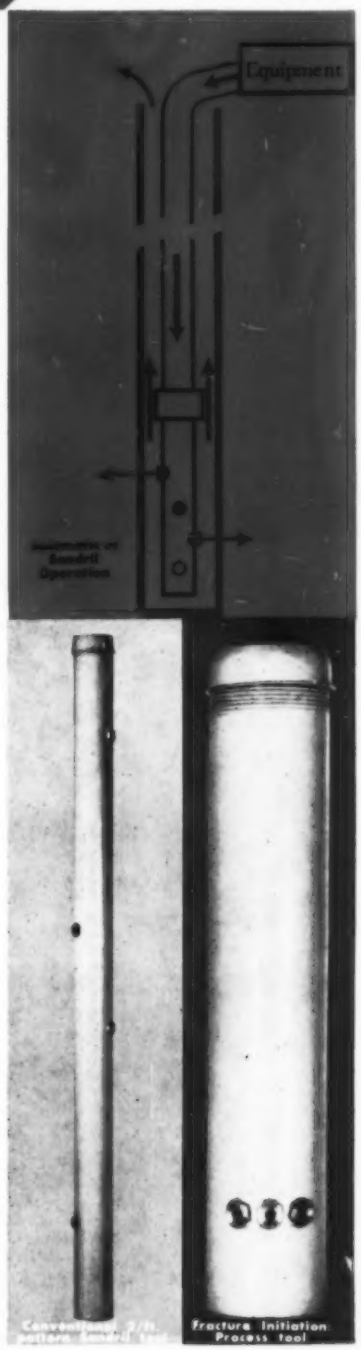
The Sandril tool is run into the hole on the end of the tubing string, then the fluid-sand mixture is pumped down the tubing, through orifices in the tool, and jetted against the casing and/or formation. Penetration is controlled by pumping time.

Treatment immediately following perforating may be accomplished down the annulus, or the annulus and tubing, since the tool is designed with a ball-and-seat valve in the bottom. To treat, the ball is circulated out after perforating.

With Sandril, there is no shattering of cement, no burring as with explosive-type perforating, and no projectile or carrot to obstruct the perforations.

Actual field applications show many instances where deep penetration with Sandril is the only effective answer to perforating problems, and many more where Sandril is much superior to any other method.

Put Sandril's controlled penetration to work in your well service program. Call your Western Engineer.



THE WESTERN COMPANY

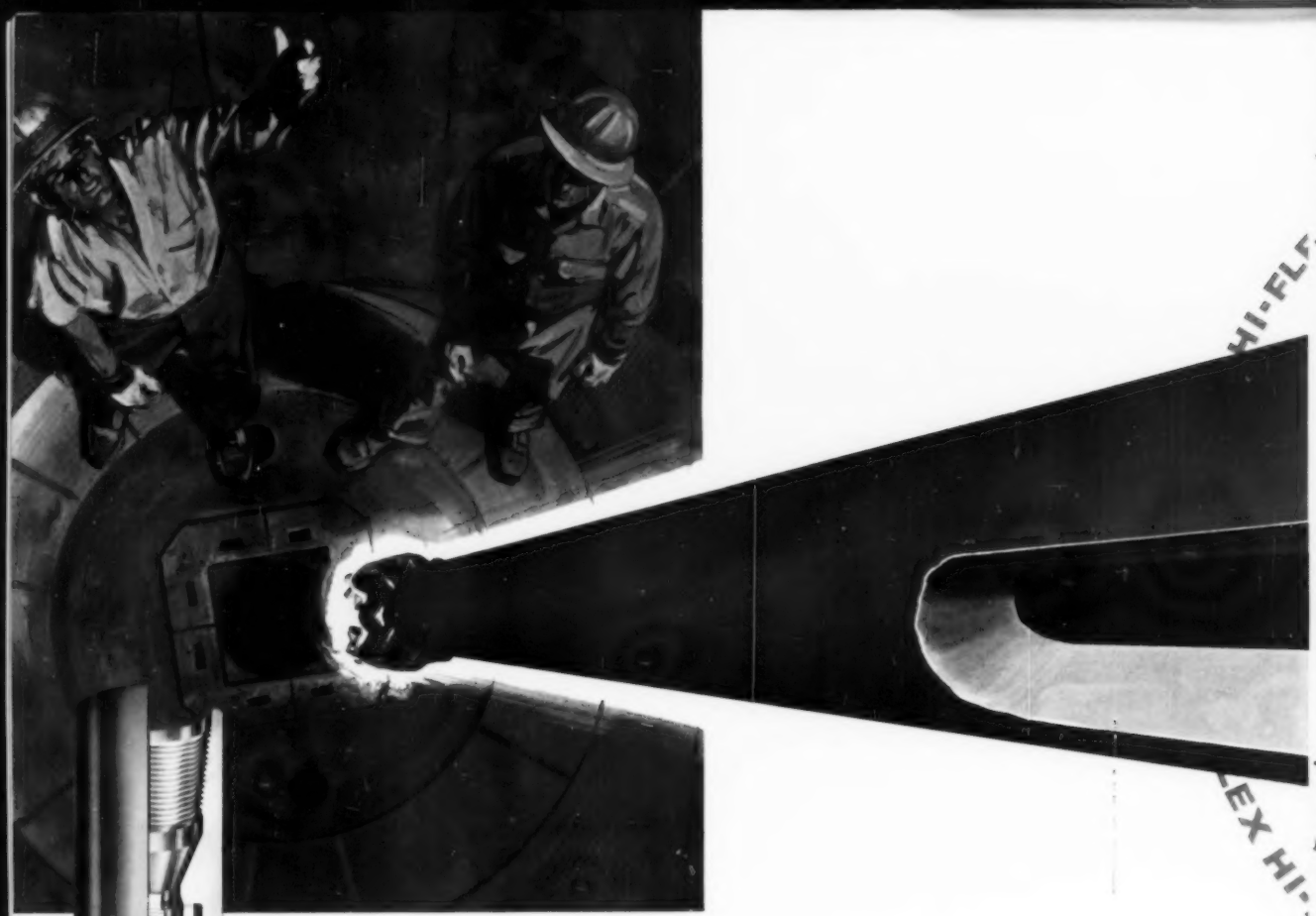
WESTERN Engineered

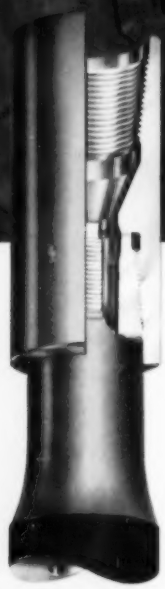
ENGINEERING LEADERSHIP 20 YEARS 1939-1959

WESTERN ENGINEERING MAKES THE DIFFERENCE!

General Offices: P. O. Box 186, Fort Worth, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD





The Reed HI-FLEX treatment prevents fatigue cracks and increases the life of drill collars. This treatment work hardens the surface of the steel. It places the skin of the metal under compression so that it can withstand the stress reversals that cause fatigue cracks. HI-FLEX is an exclusive REED process that gives better distribution of the stresses and better control of the stressed skin than any other known process.

Call the Reed man in your area and let him give you the full story on REED HI-FLEX Drill Collars —and the complete line of REED quality products.

REED

DRILL COLLARS

REED ROLLER BIT COMPANY

Houston 1, Texas

EXPORT OFFICE: 1011 INTERNATIONAL BLDG., NEW YORK 20, N. Y.

GULF COAST, MID-CONTINENT, ROCKY MOUNTAIN AND CANADIAN DISTRIBUTOR FOR MARTIN-DECKER PRODUCTS

REED'S ROLLIN'

REED...only Reed offers HI-FLEX DRILL COLLARS AND CONNECTORS

"Lubricate Threads Right"

" . . . Normal drilling operations call for a low-friction, antigalling compound. It should be put liberally on the threads and shoulders of the pins and boxes and spread with a brush. Don't rely on the pin to spread the dope into the box during make-up. Good use of thread lubricant is especially important on new joints." . . . . . Oil and Gas Journal, October 8, 1956.

WECO Tool Joint Compounds meet every requirement for efficient drill string thread lubrication. **WECO Compounds** always stay soft in the can regardless of weather extremes and never require thinning. They will not squeeze out under high well temperatures or torque pressures.

WECO No-Gall Tool Joint Compound contains more than 50% Pure Metallic Zinc dispersed in a neutral oil with a tacky additive.

WECO Lo-Tork Tool Joint Compound is a 50% Metallic Lead base compound with the finely screened lead suspended in a neutral oil with a tacky additive.

Your Supply Store always maintains complete stocks of **WECO Compounds** . . . Order the compound you need today.

C-3-59

WECO®

WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS

Division of CHIKSAN COMPANY *a subsidiary of*
FOOD MACHINERY AND CHEMICAL CORPORATION

fmc

Scientific programming on the rig floor to . . .

Obtain Optimum Bit Life

"Is the bit green — or dull?" Here's a formula to eliminate some of the guesswork related to the drilling industry's biggest everyday decision

William K. Holstein
Purdue University
West Lafayette, Indiana

THE PETROLEUM INDUSTRY probably uses more scientific programming than any other U. S. industry.

There has not yet, however, been a significant use of scientific programming in drilling segment of the industry where the men on the rig are also constantly faced with decisions involving several variables.

As an example of what might possibly be accomplished with scientific programming in the field, a hypothetical "decision rule" is developed here indicating that it is possible to aid the drilling engineer in the decision process.

Decision Rule

The specific problem for which the decision rule was developed is that of choosing the optimum time to remove a worn rotary drilling bit from the hole.

With the deep wells that are now being drilled, pulling the drilling bit represents a difficult, day-in-and-day-out decision for the drilling engineer. If he pulls the bit before it is worn out, he makes a round trip before it is actually necessary and incurs an expense by not having the bit turning to the right for its full useful life.

If, on the other hand, he pulls the worn bit too late, the bit has been wasting time on the bottom when a good bit should have been drilling effectively.

Obviously there is a time between the two extremes which represents the correct balance between cost of bit, rig costs, and time.

Assumptions

To determine this optimum bit life, we will make these assumptions:

1. Drilling speed is fairly constant throughout the useful life of the bit and drops sharply when the bit is worn out.
2. Rig costs, including labor, equipment charges and power have been estimated at $4 per ft.
3. Bit cost is $200.
4. All drilling by this particular bit will be in rock of fairly uniform hardness.

The decision rule will be based on a cost function which we now proceed to determine.

Let: T = optimum bit life in feet of rock drilled
X = actual feet drilled with bit
R = rig costs, assumed to be $4 per ft
B = bit cost, assumed to be $200

Bit Pulling Costs

Costs associated with pulling the bit before optimum are:

Rig costs created by the extra round trips over the optimum number had the bit been left in the hole for its full useful life. These costs can be represented by $R(T-X)$ or the rig cost per foot times the number of feet less than optimum that the bit actually drilled.

Bit cost, or the charges made to recognize the fact that the bit still had some useful life when it was removed. This cost can be represented as a fraction of original cost

$$\frac{B(T-X)}{T} .$$

Costs associated with pulling the bit too late involve only rig costs since the bit was used to its full useful life. These charges can be represented by $R(X-T)$ or the rig cost per foot times the depth that the bit drilled over optimum.

Loss Function

Combining these costs into a cost or loss function (L) we obtain:

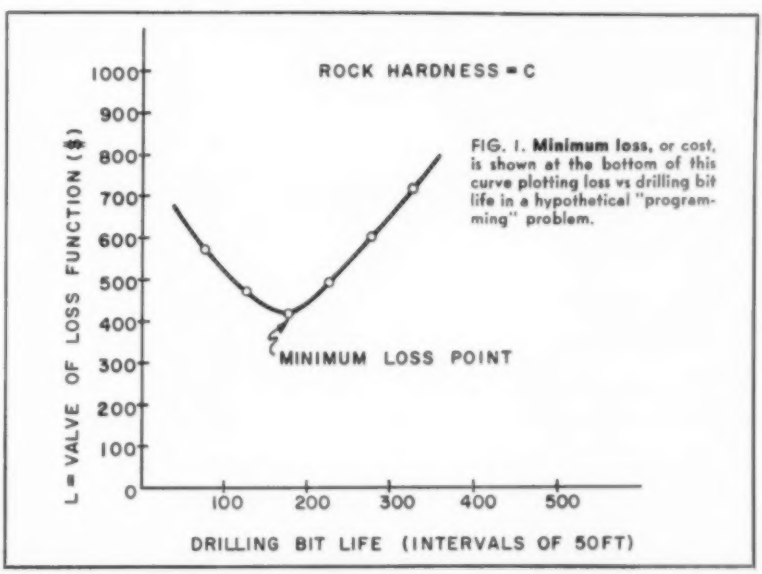


FIG. 1. **Minimum loss,** or cost, is shown at the bottom of this curve plotting loss vs drilling bit life in a hypothetical "programming" problem.

INCREASE PRODUCTION

CLEAN OUT CHOKING SAND

Excessive sand and sediment holds back your oil. For fast, easy cleanout with fewer round trips and less downtime, use world famous Miller Sand Pumps.

Write for descriptive price list.

SAND PUMP SIZES IN STOCK

O.D.—2½, 3, 3½, 4¼, 5, 5½, 7 in. Lengths, 20, 25, 30 ft.

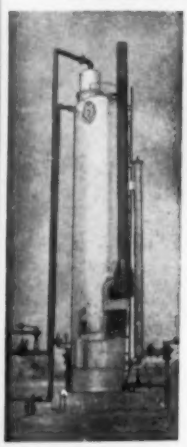
Composite Catalog Page 3400

MILLER SAND PUMPS

Miller Sand Pump Co.
General Offices, Box 4516
Oklahoma City 9, Okla.

EXPORT OFFICES
30 Rockefeller Plaza
NEW YORK 20, N. Y.

For
OPERATING ECONOMY



TYPE P-V PRESSURE TREATERS

M&V TANK COMPANY
Wichita Falls, Texas

TANKS - TREATERS
SEPARATORS

Steel Fabrication
for the Oil Industry

$$L = \text{In}\,(X \leqslant T) \cdot \left[R(T-X) + \frac{B(T-X)}{T}\right] + \text{In}\,(X > T\ R(X-T)$$

where we define the indicator function In ( ) such that the indicator function of a true statement = 1 and In (false statement) = 0. Thus, in the above loss function the term in large brackets will be multiplied by one when X is less than or equal to T but will drop out when X is greater than T since at that point the indicator function is zero.

This loss function can also be expressed in terms of two summations, namely:

$$L = \sum_{X=0}^{T}\left[R(T-X) + \frac{B(T-X)}{T}\right] f(X) + \sum_{X=T+1}^{\infty} R(X-T)\, f(X)$$

To solve this equation and determine specific values of the loss function which we can minimize for our optimum decision, we require a past record of drilling bit life in rock similar to that in which we are now drilling. For our example we may assume a search of past drilling records revealed the following information.

Total depth drilled by bit, ft	Percent occurrence
0-50	11
51-100	7
101-150	19
151-200	27
201-250	9
251-300	3
301-350	0
351-400	12
401-450	10
451-500	2

If we now define some terms relating the above date to probabilities, we will be able to solve the equation for any values of X.

Each of the terms is expressed as a function of T, the optimal distance to be drilled by the bit.

(a) f(T) = probability that T will be the depth that the bit will drill effectively. In this case it is simply the percent occurrence over 100. From the above data f(175) = .27 since 175 lies between 151 and 200 and the probability for that interval is .27.

(b) F(T) = cumulative probability, or the sum of the f(T)'s up to the desired point. F(175) = .11 + .07 + .19 + .27 = .64.

(c) E(T) = expected or average value of T, which is simply the sum of all T f(T).

(d) F*(T) = sum of T f(T) up to a desired point.

With these definitions now in mind the loss function is reduced to the following equation.

$$L = RT\,F(T) - R\,F^*(T) + B\,F(T) - \frac{B}{T}F^*(T) + R\,[E(T) - F^*(T)] - RT\,[1 - F(T)]$$

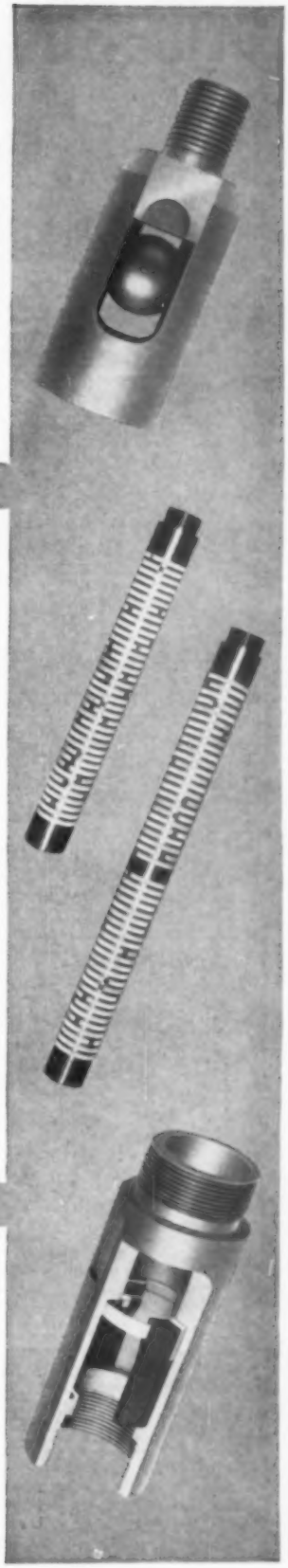
Now substituting values for F(T) and F*(T), (which can be obtained as above from the assumed data,) into the equation along with the constants and values for T (use the mean of the interval. Example: 25 for 0-50 interval) we can determine the loss associated with each interval. Plotting these losses against the bit life intervals gives the U-shaped curve shown in Fig. 1. Obviously the bottom c the curve, indicating the minimum loss, represents the optimum drilling depth for the particular drill bit under consideration. Therefore, lacking any other conclusive evidence which would indicate when to pull the bit, we could eliminate wild guessing and act according to our statistical decision rule to pull the bit somewhere between 151 and 200 ft of drilling distance.

Admittedly the decision rule we have developed represents a rather rough rule good only within 50 ft. However, with actual, more refined data we would be able to develop a much more useful rule.

The important thing, however, is that this example brings out the fact that there is a place for statistical decision theory or scientific programming in the field, where it can be an aid in numerous decisions facing the drilling engineer. ★ ★ ★

William K. Holstein, *a recent MS graduate in industrial management from Purdue University working toward a PhD in industrial economics at Purdue, where he is to teach in the department of industrial management. Holstein also holds a bachelor of chemical engineering degree from Rensselaer Polytechnic Institute and has completed the Texas A&M short course in geology. He has done research and development work at Socony Mobil Oil Company's Paulsboro, New Jersey, labs and worked in Shell Oil Company's drilling and producing training program in East Texas.*

Getting **Value Received** is a prime requirement in your efforts to REDUCE LIFTING COSTS. Giving value received has always been our prime objective.



THE MARTIN PLUNGER is valuable to you because it can be used over and over by replacing only the rings — **plus** the bonus of longer tube life, due to slower wearing action of the resilient rings.

THE MARTIN RUBBER GUIDE CAGES are valuable to you because of their remarkable lasting qualities — **plus** the bonus of improved Ball & Seat life.

"Worth their weight in Gold" would not be an exaggeration, in some cases of extreme savings with these products.

IMMEDIATELY AVAILABLE . . . in all sizes and styles from our Tulsa plant. Sold by all supply companies and stocked at many points. Fully detailed in Composite Catalog, except for recent improvements mentioned below.

The Plungers illustrated are our new standardized 1½ ft. and 2 ft. lengths which screw together to make longer (Box & Pin, cage thread) plungers. You meet many requirements with just a few pieces. Readily interchangeable.

"Extra Clearance" cage guides are now available to give extra ball clearance for large foreign particles, such as Frac Sand, Gyp particles, scale and for viscous fluids. Readily interchangeable or replaced.

JOHN N. MARTIN

Manufacturer

9 W. BRADY STREET • TULSA, OKLAHOMA

ONE SOURCE...ONE RESPONSIBILITY
GARDNER-DENVER

Compressor

Cooling system

Controls

Prime mover

Packaging

Field start-up

Servicing

"HOW'S IT GOING TODAY?"

Your Gardner-Denver oil field specialist calls back after the sale . . . takes pride in knowing that all units are running to your satisfaction. Count on him for service in the hour of need. He represents our 100-year philosophy of growth: *There's no substitute for men.*

Consult Gardner-Denver for the gas compressor package that's Gardner-Denver-engineered *all the way*. Call our nearest oil field office or write for descriptive literature.

GARDNER-DENVER stocks compressor units in all standard types and sizes at our Dallas oil field plant.

GARDNER-DENVER engineers the cooling system, separators, controls and other component parts of the complete package.

GARDNER-DENVER selects the power unit to perform efficiently and economically with the compressor load.

GARDNER-DENVER packages all components on a heavy steel skid . . . assembles and tests the unit to meet your needs.

GARDNER-DENVER ships directly to your field location . . . helps to install and place in operation.

GARDNER-DENVER provides field service to keep your compressor in top running condition.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

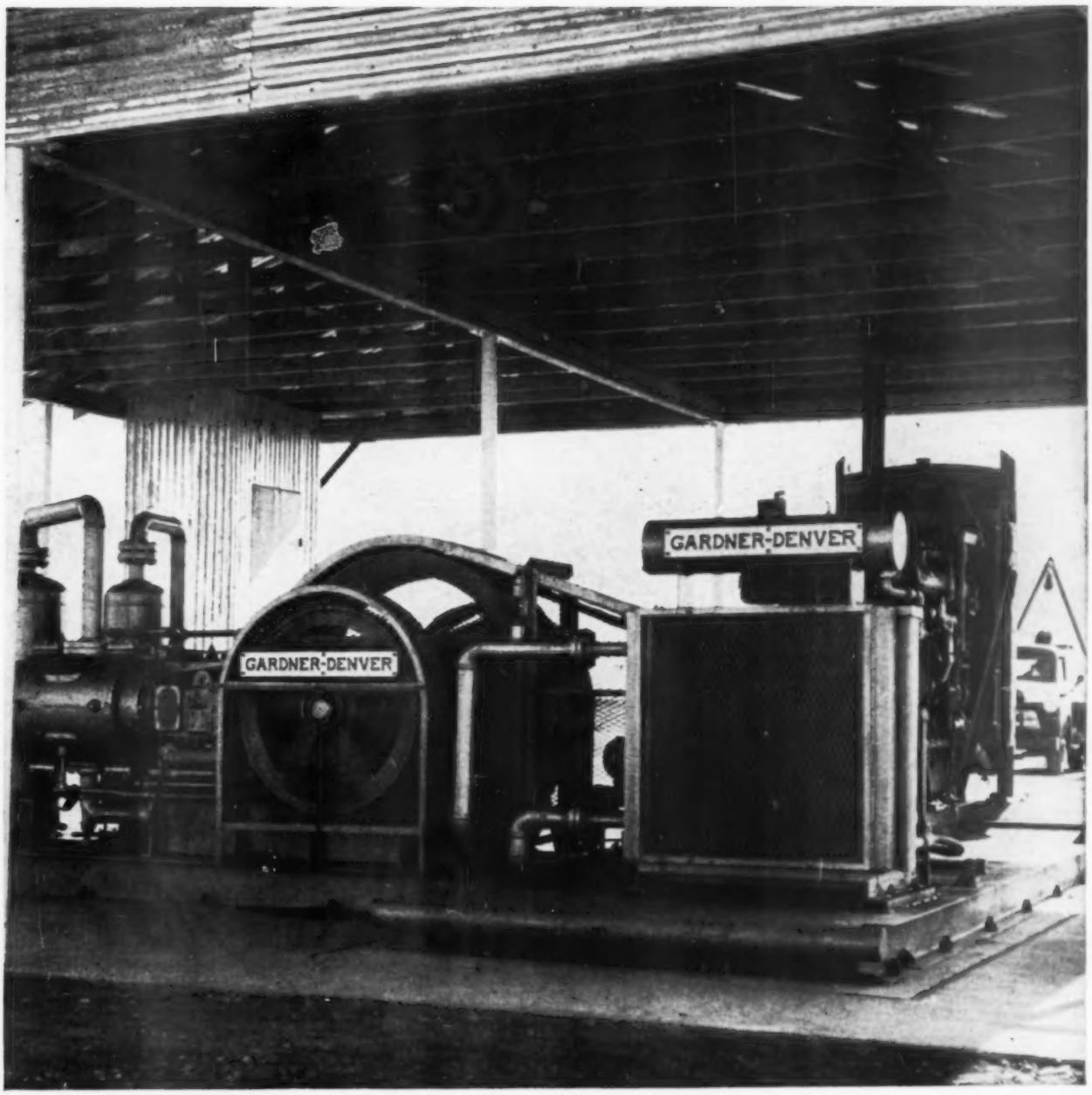
GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario
Gardner-Denver Export Division, 233 Broadway, New York 7, N. Y.

Oil Field Offices: Casper, Cleveland, Columbus, Corpus Christi, Dallas, Denver, Durango, Edmonton, Ellinwood, Evansville, Houston, Huntington, Jackson, Kansas City, Lafayette, Los Angeles, Mexico City, New Orleans, Odessa, Oklahoma City, Pittsburgh, San Francisco, Shreveport, St. Louis, Tulsa, Wichita, Winnipeg

FOR YOUR ENGINEERED COMPRESSOR PACKAGE

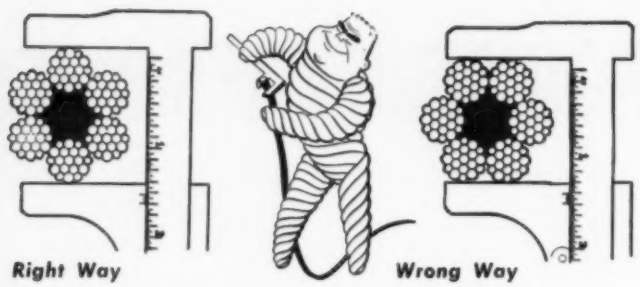


FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Tuffy® Wire Rope Tips

When Sheaves, Sockets and Clips Misfit... Your Pocketbook Will Be Hard Hit

How to Measure Rope Diameter



To get the most service, efficiency and safety out of wire rope operation, rope and sheaves must be precisely fitted to each other. There's only one right way to measure rope diameter: use machinist's calipers and be sure to measure the **widest diameter.**

A slight shift of the rope in the calipers, as shown above, will give you a misreading which would result in ordering an undersize rope. Note that the measurement at right shows ⅛" under correct diameter. Be sure to double-check every time!

Tuffy Balanced Standard Rotary Line helped drill the world's deepest well—Wildcat I-EE in Pecos County, Texas. This rotary line is famous for top performance in use with standard rigs in any formation. It also does an outstanding job with jacknife rigs in deep drilling beyond 6000 feet.

Tuffy Balanced Jacknife Rotary Line: Made to the special needs of jacknife rigs drilling to 6000 ft. Has extra strength, with greater flexibility to move at higher speeds over the smaller sheaves and drums of jacknife rigs, and to give better reeving and spooling.

How to Check Groove Diameter

No Go *Just Go*

Groove diameter of a sheave or drum must never be less than the actual calipered diameter of the new rope. When a new rope is installed on old equipment, use a reliable groove gauge to make sure the tread or bearing surface of all sheaves is of sufficient size to avoid pinching the rope.

Kick Out Worn Sheaves

Old sheaves may never die, but in "fading away" they develop conditions which shorten rope life. Sheaves with grooves corrugated with rope lay impressions should be replaced with new ones before new wire rope is installed.

How to Measure Tread Diameter

Easy, and important. Select the smallest sheave or drum to be used with the new wire rope, and measure actual diameter at lateral center (shortest dimension) of tread.

Tuffy Balanced Slings & Hoist Lines This team has made a name for cutting hoisting and downtime costs in all types of materials handling. Tuffy Hoist Line gives the balanced combination of strength and flexibility needed for a longer running rope. Tuffy Slings are made of an extra flexible, high-strength machine-braided fabric that smooths out uninjured after knotting or kinking.

FREE!

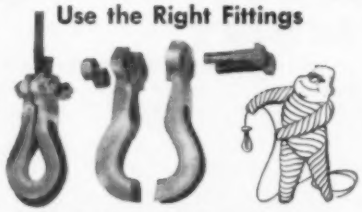
Complete handbook of wire rope use in oil field service

Latest, most complete information ever compiled on the subject in one publication. Shows the various rope constructions used by the oil industry, and gives full data tables on each. Includes (in their entirety) "A.P.I. Specifications for Wire Rope" and "A.P.I. Recommended Practice on Application, Care and Use of Wire Rope for Oil Field Service."

Write Union Wire Rope Corporation, 2106 Manchester Ave., Kansas City 26, Mo. Specialists in high-carbon wire, wire rope, braided wire fabric and stress relieved wire and strand.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Use the Right Fittings



Right fittings add life expectancy to wire rope. Fittings which derive holding power from crimping action are harmful.

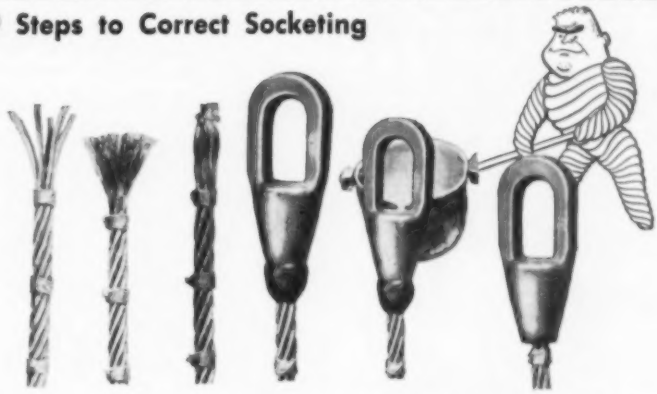
Shown here is a clamp that has no "wrong side"—can be put on either way. It snugly saddles the rope, grips larger surface area in such a way that loads are carried almost entirely by friction instead of crimping action. Combined in its two parts is a thimble. The parts are interlocked to prevent collapse of the thimble and eliminate all shear on the bolts.

Recommended sizes:

Diameter of Rope	Min. Dia.	Max. Dia.
¼ - ⅝	+ 1/64"	+ 1/32"
⅜ - ¾	+ 1/32"	+ 1/16"
⅞ - 1⅛	+ 3/64"	+ 3/32"
1¼ - 1½	+ 1/16"	+ ⅛"
1⅝ - 2¼	+ 3/32"	+ 3/16"
2⅜ and larger	+ ⅛"	+ ¼"

New ropes are usually over-size. It is advisable to have groove diameters of sheaves or drums as large as the actual calipered diameter of the new rope, or slightly larger. We recommend sizes as above charted.

9 Steps to Correct Socketing



1. Securely seize and serve with soft wire ties before cutting, and have at least two additional seizings placed at a distance from the end equal to the length of the basket of the socket.
2. When the rope is properly seized, take off the end seizing. Cut the fiber center back to the seizing, as shown in 1 above. Untwist and broom out the wires. See illustration 2.
3. Clean the wires for the distance they are to be inserted in the socket. Use benzine, naphtha, gasoline or other solvent. Then wash off in boiling water or boiling ammonium chloride used in Step 5.
4. Then dip cleaned wires in commercial muriatic acid to a depth not greater than ¾ of the cleaned length of wire. Keep the wires immersed for 3 minutes, or until the acid has thoroughly etched each wire. Be sure acid does not contact any other portion of rope.
5. Immerse wires into boiling ammonium chloride. A white coating will be left on the wires.
6. Place a temporary tie wire over the ends of the cleaned wire (see illustration 3). Be careful not to get the cleaned wires greasy or oily.
7. Insert the rope end into bottom of socket. Remove temporary tie wire.
8. Holding the rope vertically in a vise, set the socket so that the wires are flush with top of the socket basket and seal the bottom with putty or clay (See illustration 4). Pour in among the wires about ½ teaspoon of sal ammoniac crystals.
9. Pour molten zinc into the basket until it is full (see illustration 5). When zinc is solidified, the seal is removed and socketing complete as shown in illustration 6. The zinc must not be too hot or it will anneal the wires, particularly of small ropes. Temperature must not be above 925° F. Use pine stick test: if stick chars but does not ignite, the zinc is ready to pour. Overheated zinc will have a red color and stick will catch fire. When zinc has solidified sufficiently, the socket may be plunged into cold water.

FREE!

Complete Splicing and Socketing Manual with engineer's notebook on wire rope constructions and specifications. Write for your copy now. Address Union Wire Rope Corporation, 210 Manchester Ave., Kansas City 26, Missouri.

Specialists in high carbon wire, wire rope, braided wire fabric, stress-relieved wire and strand.

UNION Wire Rope is Balanced for Greatest Efficiency, Service Life and Safety

Every one of the Tuffy Special Purpose Ropes has a different combination of such properties as strength, toughness and flexibility.

That's because each Tuffy is "job prescribed"—made to perform best under the conditions of its special use.

You hear a lot about extra strength in wire rope. It's no trick to design rope with very high strength. The main thing is to get the proper balance of strength with other qualities needed.

Which is just what you get in every Union Wire Rope product. Why settle for less?

Your Tuffy Distributor Will Help You Get All the Extra Service Life We Build Into Wire Rope

UNION Wire Rope

ARMCO

Subsidiary of ARMCO STEEL CORPORATION

OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company
Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Southwest Steel Products

New steels are born at Armco

2

HYCALOG DIAMOND CORE BITS

HYCALOG

WIRE LINE CORING RECOVERS MORE CORE... FASTER IN GULF AREA

High penetration rates were maintained on these seven wells... *with Hycalog diamond wire line coring bits*... and drill strings didn't have to be pulled for bit changes until coring was completed. Located in Webb, Matagorda, and Orange Counties, Texas, and St. Charles Parish, Louisiana, they are typical of coring jobs throughout the Gulf area.

SIZE BIT	NO. CORES CUT	FEET CUT	% RECOVERY	AVERAGE FT./HR.
7⅝ x 1¾	10	129	100.	7.15
7⅝ x 1¾	12	130	97.	8.25
6¾ x 1¾	5	62	99.9	4.65
7⅝ x 1¾	17	155	80.	5.24
7⅝ x 1¾	37	465	95.5	4.2
7⅝ x 1¾	32	463	87.	6.9

Why not let Hycalog diamond core bits set a record on your next coring program? *And ask us about Hycalog* GAS CHRONO-FRAC *well logging services.*

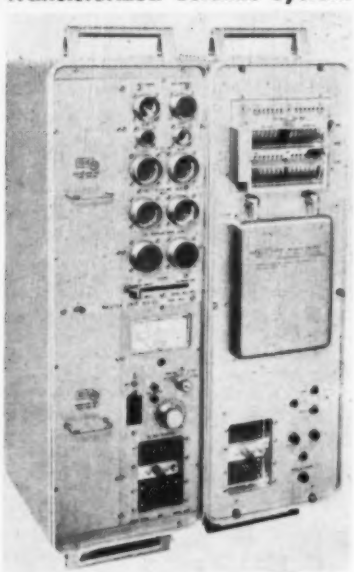
Hycalog, Inc.
505 AERO DRIVE
SHREVEPORT, LOUISIANA

BRANCH OFFICES IN PRINCIPAL OIL PRODUCING AREAS

DIAMOND BITS DIAMOND CORING
WELL LOGGING CORE ANALYSIS

New Drilling and Producing EQUIPMENT

Transistorized Seismic System



SIE announces the introduction of its new PMR-20 seismic system, a 24-channel transistorized system complete in 2 compact units. It provides high-fidelity frequency modulated recordings on standard SIE magnetic tapes from the output of standard geophysical amplifiers. The system consists of 2 units — the 50-lb MR-20 transport, housing the recording drum, drive system, and fixed or movable recording heads, and the 40-lb MU-20 master unit, in which the modulators, demodulators, and auxiliary electronics are contained. Each unit contains its own transistorized power supply. *Southwestern Industrial Electronics Company, a Division of Dresser Industries, Inc.*

Circle number (1) on reply card.

Inverse Top Cylinder Oiling System

The Marvel inverse top cylinder oiling system, designed to improve engine upper cylinder operation and to reduce maintenance costs, is announced by Emerol. Installed on engines operating well-drilling equipment, power generators, trucks, autos, and marine engines, the oiler provides correct lubrication for high heat upper cylinder engine areas which normally receive scant lubrication. The oiler automatically feeds lubricant into upper cylinders, according to engine load and speed. *Emerol Manufacturing Company, Inc.*

Circle number (2) on reply card.

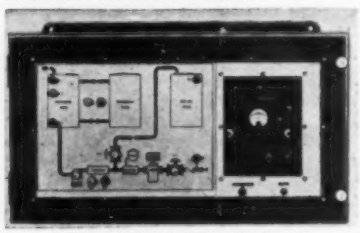
Split-Top Stuffing Box

Alten Foundry and Machine has announced a new split-top stuffing box for packing off pumping wells. Split-top design permits complete removal of the top and upper bushing. Packing can be removed with greater safety. Housing is made of ductile iron and has been load tested in excess of 100,000 lb. Working pressure is reported as 1500 psi

Lubricants are forced directly into the center of the packing through a single fitting. Accommodates rod and liner sizes from 1⅛ in. to 1½ in. by changing only bronze wear bushings. *Alten Foundry and Machine Works, Inc.*

Circle number (3) on reply card.

Electric Control Panel



A new model LACT-600 electric control panel by Instruments, Inc. is designed to provide dependable and automatic delivery of merchantable oil to the pipeline. One section of the panel is a graphic illustration of the transfer system, with lights indicating liquid levels and quality, i.e., BS&W content of the crude. Part of the panel is a BS&W monitor utilizing a capacitance type probe in the discharge line. The entire system is housed in a single dust-tight wall mounting case. *Instruments, Inc.*

Circle number (4) on reply card.

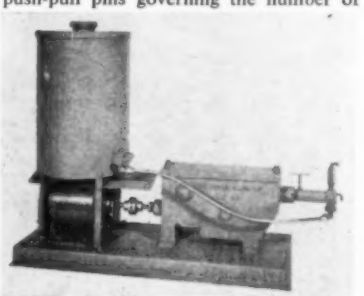
Swab for Tapered Tubing Strings

A new swab, developed by the Oil States Rubber Company, makes possible the swabbing of wells with tapered tubing strings from top to bottom. The swab consists of 3 mandrel sections of 1-piece construction. The upper mandrel section is the sinker bar. A latching nose guide on the top swab holds the 2 swabs together until the cross-over swage is reached and then trips, releasing the lower swab. In most respects, the 2-stage swabbing is very similar to normal swabbing at comparable depths. *Oil States Rubber Company.*

Circle number (5) on reply card.

Positive-Feed Chemical Pump

A new motor-driven chemical pump can be adjusted in seconds to any feed volume from 0 to 64 gal per day. Key to its operation is an index wheel with 10 push-pull pins governing the number of



injections per minute. Operator sets each pin to add or skip an injection stroke with every revolution of the index wheel. A printed chart gives correct settings for any desired feed volume. Made by Western Machine Company, the pump handles injection pressures up to 2000 psi with a ⅜-in. piston and close-coupled ¼-hp motor. With a larger motor, pressures may range to 3000 psi. *Beal Equipment Company.*

Circle number (6) on reply card.

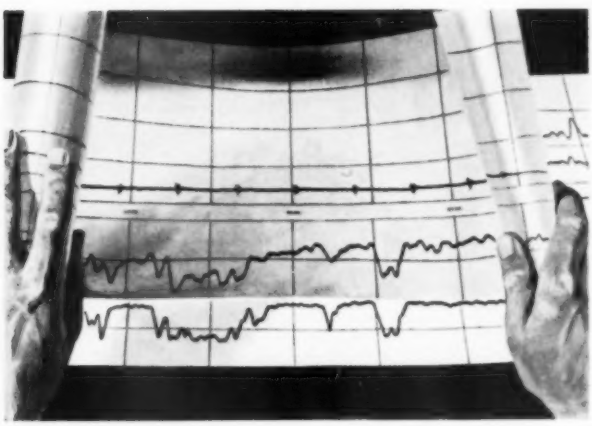
GUN-GAMMA RAY*

. . . another contribution

to greater efficiency

in oil-well completions

by Schlumberger



3 Operations – 1 Trip in the well

The combined Gamma Ray-Collar Locator-Perforator gives you positive depth control plus casing perforations on one trip in the well. Here is how this means more efficient operation for you:

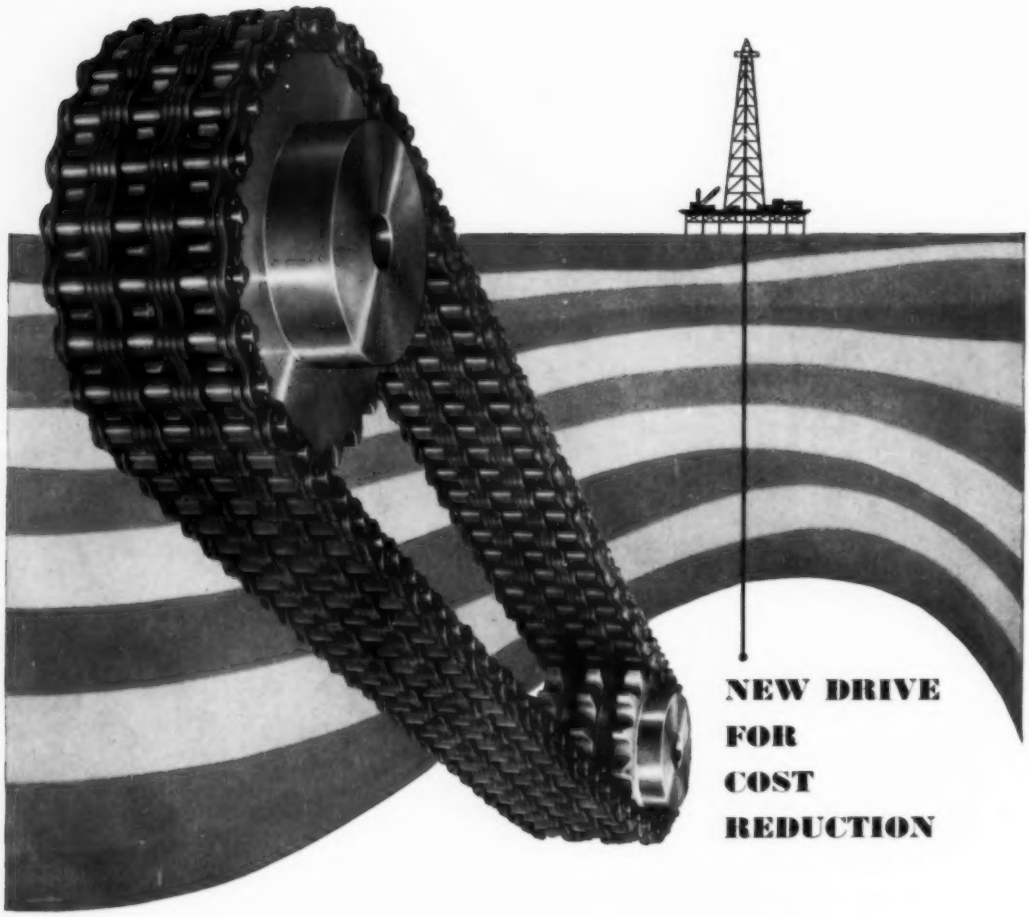
- *Lower Costs*—Saves costly rig time.
- *Absolute Accuracy*—Gamma Ray correlation with open-hole log positions perforator at exact depth. Collar Locator gives reference depth for additional guns and often locates perforations immediately after shooting.
- *Gamma Ray-Collar Log*—becomes a permanent well record.

Call your nearest Schlumberger office for a discussion of this modern perforating service.

THE EYES OF THE OIL INDUSTRY*

SCHLUMBERGER

*plus Casing Collar Locator



NEW DRIVE FOR COST REDUCTION

Whitney's *new* chain drive developments are helping to reduce oil field production costs *where it counts* . . . keeping rigs operating under the toughest shock loads and punishment that drilling schedules can hand out.

Here's why important producers everywhere are specifying these new cost-cutting chain drives:

√ An exclusive *fatigue-resistant* Whitney Process offsets *excessive operational stresses* in the chain —assures new durability and freedom from excessive wear, breakage and dollar consuming downtime. Each precision Whitney Chain part is specifically designed, heat treated and assembled to meet your severest service requirements.

√ And Whitney's "*Fluid-Fit*" design features all cottered chain construction with slip-fit link assemblies . . . no tough, time wasting repair work when assembling or adjusting your chain drives.

√ Another important design advance is Whitney's High-Capacity Roller Chain. This new, *compact* chain drive may provide an engineered solution where space limitations and higher horsepower requirements are important factors in power transmission.

Backing up these design advances is Whitney Chain *service* . . . a complete line of packaged, precision steel chain, always available from oil country warehouses and oil field supply stores everywhere. Each point brings you field *engineering service* and prompt delivery from stock. Write for complete, practical catalog literature.

Whitney

CHAIN COMPANY

A Subsidiary of FOOTE BROS. GEAR AND MACHINE CORP. 4591 S. Western Boulevard, Chicago 9, Illinois

ROLLER CHAIN • CONVEYOR CHAIN • SPROCKETS • FLEXIBLE COUPLINGS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Heavy Steel Flame Arrestors

National flame arrestors, designed to stop all flame propagation outside of firetubes, are of welded, heavy steel construction and will withstand any explosion inside the tube as well as prevent

any flash from going through the element. They are available in 2 types for installation on all existing fired production equipment. Both types can be supplied with push-button pilot lighters or automatic robot pilot which will automatically light the pilot with no attending personnel and will automatically shut off the gas supply in case of failure of any part of the burner system. *National Tank Company.*

Circle number (7) on reply card.

Rock Bit Underreamer

A new underreamer utilizing rock bit cutters has been announced by A-Z International Tool Company. This tool can be run to any desired depth with the cutters in closed position; when the tool is in place pump pressure is built up to increase velocity of fluid across the bit nozzle forcing a piston upward to expand the cutter wings. Another set of pistons rigidly holds the cutter wings in position. The rock bit cutters are made of carburized steels and are hard-faced with tungsten carbide for maximum footage. *A-Z International Tool Company.*

Circle number (8) on reply card.

Jar-Keyseat Broach

A new jar-keyseat broach containing superior design features has been put into production by the Hunt Tool Company. The triple-action tool has been designed to eliminate sticking of drill collars in keyseats, smooth out sharp bends and crooks in holes, and to remove ledges and shoulders which often cause tool to hang up coming out of the hole. The tool is claimed to be the only one available that provides a 3-way jarring, broaching, and reaming action. *Hunt Tool Company.*

Circle number (9) on reply card.

New A-C Motor Line

A new line of integral horsepower a-c motors has been announced by Reliance Electric. Called "Duty Master" motors, they are available in sizes from one through 250 hp in protected (open), weatherproof, totally-enclosed, corrosion-proof, and explosion-proof enclosures. Designs include polyphase, ball bearing, vertical and horizontal mounting arrangements with feet or footless, with NEMA C-face, D-flange, or P-base brackets. *Reliance Electric and Engineering Company.*

Circle number (10) on reply card.

slim hole EQUIPMENT

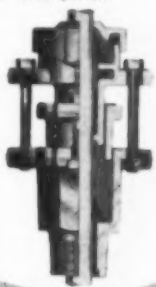
FIRST from HERCULES

HERCULES is First to provide a complete line of equipment for this new Oil Production Technique.

The use of 2½" tubing for casing and 1¼" or 1½" tubing as the oil string has made it necessary to develop new equipment specifically for this purpose. In response to the requests of production men, Hercules now provides tested and proven production equipment for Slim Hole Drilling. The well-known Hercules "Tee-Type" Duplex Stuffing Box and the new 2½" Hercules Type "HF" Tubing Head are incorporated in this typical Slim Hole well hook-up. Hercules "Tee-Type" Duplex Stuffing Box is now available in 1¼" and 1½" tubing sizes (plain or EUE) with the same packing and parts used in all Hercules Duplex Stuffing Boxes.

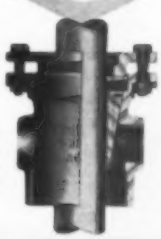
HERCULES "TEE TYPE" DUPLEX STUFFING BOX A combination Tee and Stuffing Box with female thread to screw directly onto the 1¼" or 1½" tubing, eliminating one-threaded connection and resulting in a considerably shorter hook-up. 3000 PSI test. Approximate height 15". Weight 33#. Price $31.00.

HERCULES TYPE "HF" SLIM HOLE TUBING HEAD Features the safety and quality that you receive in all Hercules tubing heads at a minimum price. Pressure cast, one piece steel body with 2" side outlets and heat-treated hinged slips. Over-head packed with neoprene packing. 1000 PSI test. Height 8½". Weight 19#. Price $49.50.



HERCULES "REGULAR TYPE" DUPLEX STUFFING BOX Proven design and dependability render this stuffing box unequalled for the difficult pumping situations as well as easy ones. Constructed from malleable iron, it protects workers from the danger of shattered metals should rods accidentally drop. The new 1¼" or 1½" "Regular Type" Stuffing Box is ideal for use in Slim Hole installations.

HERCULES TYPE "DS" PUMPING TEES In the 1¼" and 1½" sizes these Tees are ideal for use on Slim Hole well hook-ups.



HERCULES TYPE "HF" TUBING HEAD In spite of its economical price, the Type "HF" Tubing Head is pressure cast with one piece cast body and Overhead Packed with neoprene Packing Ring. This Head is now available for 2" or 2½" Tubing to suspend ¾" to 1½" Inner String (Plain or EUE) for Slim Hole operations.

All Hercules Products for Slim Hole Drilling may be purchased through the supply store of your choice. Write for complete information.

HERCULES TOOL COMPANY

Manufacturers of Oil Field Equipment

GENERAL OFFICES AND PLANT • TULSA, OKLAHOMA

Export Representative Oil Field Equipment Co., Inc. 90 West Street, New York, N. Y.

This free Service Report shows how

OAKITE
SERVICE REPORT

Oakite ECP
engineered cleaning program

restores clogged bottom-hole pump in thirty minutes

Next time you pull out a bottom-hole pump covered with grease, mud and rust, and clogged with gyp and lime deposits—see how fast you can salvage it by Oakite ECP methods.

First the outside. You'll find that a few minutes soak in the right Oakite solution takes all the muck off the pump, leaves it clean as new. Then another short soak in the right Oakite descalant solution gets rid of the interior deposits. In just about half an hour, all told, the restored unit can go back in the line, pumping at full rate.

Oakite ECP is the Engineered Cleaning Program that saves you time and money through chemical cleaning. It is *engineered* to fit your particular operation under the experienced supervision of your local Oakite man.

For more information on salvage cleaning, write for Oakite Service Report #B 4594, "Maintaining Oil Field Drilling Equipment." Address Oakite Products, Inc., 48 Rector Street, New York 6, N. Y. Export Division Cable Address: Oakite

ECP—your economy key

OAKITE
50 1909-1959 years' leadership in industrial cleaning
SCIENCE

Technical Service Representatives in Principal Cities of U. S. and Canada

New Equipment

Light Weight Mixers

Jensen Engineering Company has announced the production of their 300 Series mixers. These side-entering mixers vary in weight from 505 to 575 lb, less the weight of the motor, on models with horsepowers from 5 to 25. The line has spiral bevel gears and an easily interchangeable mechanical seal. Vari-angle feature permits the mixer to be set at a 20-deg angle, right or left, within the tank. All models have a propeller speed of 425 rpm. *Jensen Engineering Company.*

Circle number (11) on reply card.

Replaceable Blade Bit

The J. T. Williams Company announces their new hard formation Type WC carbide insert replaceable blade bit. The bit is precision machined of forged alloy steel and heat treated in the latest type furnaces. Available in 3⅞, 4¾, 4½, and 5⅝-in. for shale, medium, and hard formations, the bits are also offered in all drill pipe connections. *J. T. Williams Company.*

Circle number (12) on reply card.

Epoxy Bonding Agents

A new group of high strength epoxy bonding agents developed by Chemical Development Corporation is used for cementing cast iron, steel, copper, aluminum, bronze, brass, plastics and other surfaces to themselves or each other. Besides bonding similar and dissimilar materials, the adhesives are used for sealing and filling gaps. These thermosetting adhesives have high impact, tensile shear, and compressive strength and will not dry out, crack, or deteriorate with age. *Chemical Development Corporation.*

Circle number (13) on reply card.

SECONDARY RECOVERY
Since 1922

PETROLEUM ENGINEERS
CABLE & STEPHENS
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING
Water Flooding Gas Repressuring
EVALUATION CORE ANALYSIS
SURVEYS ECONOMICS
Cost Estimates, Design, Installation
FIELD SUPERVISION
Phone 723-2167

High Energy, High Speed Power Take-Off

A new power take-off for high energy, high speed applications has been announced by Twin Disc Clutch Company. The unit withstands high-energy heat loads, can be applied to high-speed engines up to 3380 input rpm, and operates up to 6 months between lubrication periods. The unit's clutch overcomes the problem of high heat by means of an exclusive ventilated center plate. The unit is rated for engines developing 300 to 500 hp at speeds up to 3380 rpm. *Twin Disc Clutch Company.*

Circle number (14) on reply card.

LP-Gas Vaporizer

A new development in the field of LP-gas vaporization is incorporated in Ensign's Model "CV" LP-gas vaporizer. The unit measures approximately 3¼ in. in diam and 4½ in. in length. Primarily designed to fit between the cylinder head and water outlet connection to the radiator, the vaporizer may be mounted in any position on or near the engine. It has unusually high vaporizing capacity for its size, and is corrosion resistant and plug proof, maintaining uniform vaporizing rate for years. *Ensign Carburetor Co.*

Circle number (15) on reply card.

Strip Chart Recorder

The Rustrak strip chart recorder, believed to be the world's smallest and simplest, is available for 0-150-v or 0-300-v a-c. The units feature inkless rectilinear recording free from distortion

and house a 63-ft roll of pressure-sensitive paper. Various chart speeds are available up to 30 in. per hr. It is available for portable use or with brackets for panel mounting. *Rust Industrial Company.*

Circle number (16) on reply card.

No Hand Cranking On Portable Centrifuge

W. L. Walker Company has announced production of its portable electric centrifuge, which features many new advantages.

The lightweight, compact unit has a long electrical cord with adapter that permits it to be plugged into the cigarette lighter socket in a vehicle. The machine can be placed in a location where there is room enough for the spinner head to revolve. The machine is equipped with a 3-speed switch, and pilot light.

The centrifuge rests on rubber suction cups so that it need not be clamped

down. The machine may even be operated on the fender or hood of a car or truck. *W. L. Walker Company.*

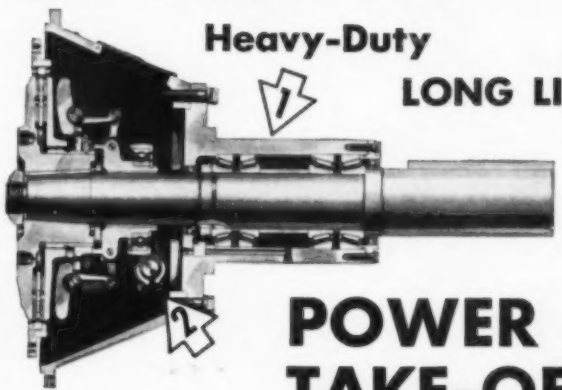
Circle number (17) on reply card.

Advances In Electrical Logs

More accurate electrical logs can be run in less time as a result of recent advances in instrumentation design by Lane-Wells. The new instrumentation permits logging at 12 percent greater speed without loss of log quality. Calibration of all curves can be made with the electrode in the well, resulting in more accurate log scales. Easier reading of the logs is a result of chart lines which are printed electronically. All scales and long spacings with the new instrumentation are identical with those provided on conventional electrical logs, insuring easy correlation with existing logs. *Lane-Wells Company, a Division of Dresser Industries, Inc.*

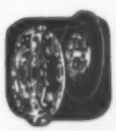
Circle number (18) on reply card.

ROCKFORD
OIL FIELD TYPE
Heavy-Duty
LONG LIFE



POWER TAKE-OFF

Small Spring Loaded


Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Power Take-Offs

Speed Reducers

1 Main Bearings Run in Oil Bath

The special, large Timken main bearings in the new ROCKFORD POWER TAKE-OFF are adjusted when assembled at the factory. They require no further adjustment—and run in a reservoir of lubricating oil.

2 Throw-Out Bearing Oiled for Life

The clutch throw-out bearing is lubricated for life and requires no further attention. Cut down on the servicing time needed by your equipment by specifying this new ROCKFORD Oil Field Type POWER TAKE OFF and save time and labor costs.

BW SEND FOR THIS HANDY BULLETIN
Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

ROCKFORD Clutch Division BORG-WARNER
1303 Eighteenth Ave., Rockford, Ill., U.S.A.
Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

CLUTCHES

B and W Inc.

SCRATCHERS AND CENTRALIZERS

for a good cement job

Pioneers in the Field

Good Field Service. **Trained and experienced B and W field servicemen — working in close cooperation with your engineering and field crews — will assist in developing and carrying out a well planned program *For a Good Cement Job.***

B and W Inc.

Well Completion Specialists

GULF COAST
Box 5266
Houston 12, Texas
Phone WA 3-6603

WEST COAST
19706 S. Normandie Ave.
Torrance, California
Phone FAculty 1-2463

101

New Equipment

Submersible Turbine Pump

Worthington Corporation announces its first submersible pump, differing from the conventional vertical turbine pump in that its motor is on the bottom end of the shaft submerged, rather than above surface. Selection of a custom-made pump can be made from a standard group of alternates. The pumps are primarily designed for use with deep settings and high heads. They are particularly appropriate where a minimum of space is available, or where noise from surface units would be objectionable. *Worthington Corporation.*

Circle number (19) on reply card.

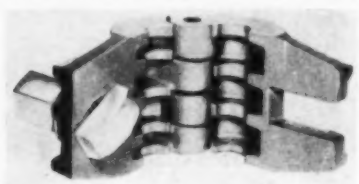
All-Weather Pumping Control

A new oil well pumping control designed to operate in spite of adverse weather conditions has been announced by the Square D Company. The enclosure has a special corrosion-resisting finish and a sealed inner compartment to protect the operating parts from dust, sand, rain, snow, etc. The control is protected from damage in electrical storms by a built-in lightning arrestor. The control circuit includes automatic time delay restarting, allowing staggered restart of several pumps in the event of a power outage. *Square D Company.*

Circle number (20) on reply card.

One-Bolt Polished Rod Clamp

A new one-bolt polished rod clamp is available in all standard sizes from Alten Foundry and Machine Works. Tee head bolt makes it possible to remove clamp



quickly and easily. The nut needs to be loosened only slightly to permit a quarter turn of the bolt head. The clamp then opens completely. The nut can be reached from any angle. Bolt, nut, and washer are cadmium-plated to resist corrosion. *Alten Foundry and Machine Works, Inc.*

Circle number (21) on reply card.

Heavy-Duty Drilling Unit

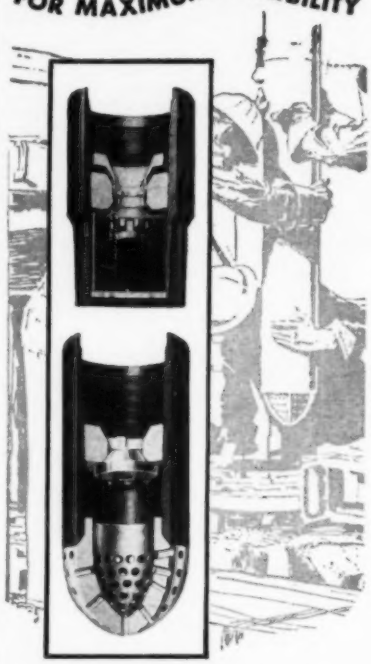
Cardwell's Model J700 is a recently-introduced 2 or 3-engine drawworks which provides an extremely versatile unit for economical heavy-duty drilling in the 5000 to 9000-ft range with 4½-in. drill pipe. Torque-converter driven, the J700 has a nominal input rating of 700 hp, with the 2 or 3-engine compound having 850 continuous-hp rating to provide 600-hp continuous converter output at the pump drive. 3 speeds forward and one reverse are provided to the main drum and rotary drive through a chain transmission with mechanically shifted gear clutches. Air-operated master clutch and brake are provided to facilitate operations. *Cardwell Manufacturing Company.*

Circle number (22) on reply card.

RECTOR

Type "O" Fill Shoe and Collars

FOR MAXIMUM FLEXIBILITY



Rector Type "O" is the only automatic casing fill equipment that permits you to stop running pipe and circulate the well as often and for as long as you want and then resume running pipe with controlled orifice fill after circulating.

Only Rector Type "O" Gives You These Advantages:

- **Automatic fill-up increases safety—speeds running time—reduces pressure surges—protects the formation.**
- **Orifice choke in the spring-loaded flapper valve assures controlled constant fill.**
- **Precision rubber molded section on aluminum flapper valve assures positive back-pressure valve.**
- **Ceramic choke inserts are easily changed, making field maintenance easy, fast.**
- **Converts to float at operator's option.**
- **Internal parts are easily drillable aluminum alloy.**

Available through your favorite supply store for use in casing sizes 4" O.D. through 20" O.D. with standard threads.

RECTOR

Well Equipment Company, Inc.

1100 North Commerce Fort Worth, Texas
Houston Plant: 2215 Commerce

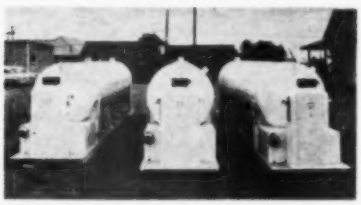
EXPORT REPRESENTATIVES:

Continental-Emsco Co.; Mid-Continent Supply Co.; Oil Well Supply Division of United States Steel Corp.

New Equipment

Service Station Propane Tanks

The first shipment of 3 service station propane tanks to Chile has been made by



Master Tank and Welding Company. Part of an order of 6 tanks, the units have a 2000-gal capacity and are complete with meters, pumps, hose and other accessories. The portable dispensing units are skid-mounted in a heavy cradle-type support. The self-contained propane dispenser makes the units ideal for filling small capacity fuel tanks. *Master Tank and Welding Company.*

Circle number (23) on reply card.

Small Diameter Tubing

The Ambridge plant of The National Supply Company has begun the manufacture of 2 1/16-in. OD seamless tubing for oil field use. Previously, the smallest size available from the company was 2⅜-in. The growing practice of producing oil from 2 or more different zones in the same well created the need for the smaller diameter tubing. Oil is produced through the strings of tubing which are suspended side by side in the casing of the well.

The Spang 2 1/16-in. OD tubing is being manufactured with an upset integral joint, in Grades J-55 and N-80. Pup joints are also available. A non-upset threaded and coupled tubing in the 2 1/16-in. OD size will be made later. *The National Supply Company.*

Circle number (24) on reply card.

Multi-Purpose Packer

Introduction of the "Cam-Lok," a versatile "pipe-wrench-in-a-packer" tool, has been announced by Brown Oil Tools. The tool is a weight-set packer, a tension tubing anchor, and a tubing catcher, being fully convertible to any of these functions right at the well. In its simplest application, it is used as a weight-set packer. It is set in tension to take advantage of pressure from below when testing, waterflooding, fracturing, acidizing, or in shallow wells where the tubing weight and casing fluid column may not be sufficient to hold the packer weight set against high bottom hole pressure. It can be used as a packer during the flowing life of a well, but when the well goes on pump, it can be converted to a tubing anchor. Less than one quarter turn of the tubing in either direction operates the unique cam mechanism to grip the casing like a pipe wrench working from the inside. This wrench grip will lock the packer in place as long as torque is held in the tubing. *Brown Oil Tools, Inc.*

Circle number (25) on reply card.

When the going gets rough . . .

RELAX

. . . if your well is equipped with a JENSEN Rotary JACK.

The deeper your well, the more important counterbalance becomes.

Improper balance can cause unnecessary damage and costly down-time.

But JENSEN Rotary Jacks *anticipate* deep well problems; they can be adjusted in minutes by just one man — standing on the ground.

For both shallow and deep wells, insist on efficient, low-cost JENSEN Rotary JACKS.

STOCKED BY YOUR LOCAL SUPPLY STORE

Made by JENSEN BROS. MFG. CO., INC.
Box 477-B, Coffeyville, Kansas
Export Office: 250 Park Avenue, New York 17, N. Y.

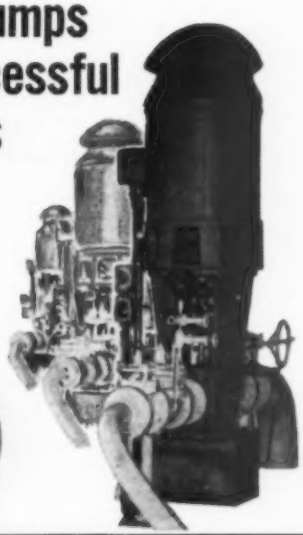
JENSEN JACKS

FIELD-PROVEN
Johnston Pumps
team up for Successful
Water Floods

Both Injection and Supply

Pumps are installed in multi-unit stations to provide COMPLETE SYSTEM FLEXIBILITY with a wide range of pressure-capacity combinations.

Pressures to 2500 psi.



1909-1959 50 YEARS JOHNSTON PUMP COMPANY

Send today for colorful bulletin.

JOHNSTON
PUMP COMPANY
A Division of
The Youngstown Sheet and Tube Company
Pasadena, California

Johnston Pump Co.
Bin K, Pasadena, Calif.
Send complete information on water flood applications:
Name
Address
Firm

New Literature

New Brushless Generator Bulletin

Characteristics of Allis-Chalmers high-speed, packaged brushless synchronous generators in 40 to 300-kw ratings are described in a new bulletin released by the company. A combination of brushless excitation system and static voltage regulation control provides the key to the generator's design. Commutators and brushes are replaced by silicon rectifiers while the static voltage regulation system provides constant voltage output up to +½ percent regulation. *Allis-Chalmers Manufacturing Company.*

Circle number (27) on reply card.

Oilfield Equipment Catalog

Raybestos-Manhattan has published a new catalog including illustrated descriptions and specifications of the company's products for the petroleum industry. The catalog contains sections on oilfield hose, petroleum hose, air, water, and steam hose, and fire hose. Also included are transmission belts, mechanical packings and gasket materials, and brake blocks. *Raybestos-Manhattan, Inc.*

Circle number (28) on reply card.

Fracturing Services

A new bulletin published by Dowell outlines the company's fracturing services. The bulletin describes the 10 basic fracturing services offered by Dowell and groups the services according to base fluids used . . . oil, acid, or water. Types of wells which benefit from the fracturing services are also discussed. *Dowell Division of The Dow Chemical Company.*

Circle number (29) on reply card.

Diacel Cement Systems

Publication of a 38-page revised technical data booklet on diacel cement systems has been announced by Drilling Specialties Company. It contains tables and other pertinent data on the application of Diacel D low-density cements and the Diacel LWL retarder and low water-loss cement additive. *Drilling Specialties Company.*

Circle number (30) on reply card.

Variable-Speed Pulleys

A new bulletin from T. B. Wood's Sons Company describes a line of variable-speed pulleys designed to eliminate freezing and sticking. The 12-page bulletin gives technical data for 5 sheaves designed for ratings of 2, 3, 5, 10, and 15 hp. Power is transmitted from the stationary flange through a removable sleeve cap which is keyed to the moving flange by torsionally resilient rubber keys. *T. B. Wood's Sons Company.*

Circle number (31) on reply card.

Gas Turbine Engines

A new bulletin from General Electric discusses characteristics of the 1000-hp class gas turbine which makes it suitable for such applications as marine propulsion, oil well servicing, and emergency or portable power generation. Specifications and illustrations are included. *General Electric Company.*

Circle number (32) on reply card.

Wire Rope Products

Seven products of the Wire Rope Division of Jones & Laughlin are described in 5 separate, 4-page pamphlets. The products are Centerfit wire rope, cable laid slings, PlastiKore and SpringKore wire rope, JalKlamp and JalLoc slings, and oil field manila rope. Each pamphlet describes the various applications for which the product is best suited. Specifications for strength and size are listed in tables. A brief guide on how to order wire rope is presented in the booklets covering these products. *Jones & Laughlin Steel Corp.*

Circle number (33) on reply card.

Consolidated Rig

Advances in the operation and performance of the National Type 55 consolidated rig are described in a new bulletin offered by National Supply. The 16-page bulletin includes completely revised drive group sections and changes in rig ratings. These 2 and 3-section drive groups provide up to the nominally rated 700 hp of the rig, which is normally considered for drilling in the 6000 to 9000-ft depth range. *The National Supply Company.*

Circle number (34) on reply card.

Metal Packing for Pumps, Engines

A new bulletin dealing with the subject of metal packings for pumps, engines, and compressors has been published by The Garlock Packing Company. The 24-page booklet contains comprehensive data for correct selection, applications, and installation of metal packing and it is complete with explanatory illustrations. *The Garlock Packing Company.*

Circle number (35) on reply card.

Automatic Recording and Programming System

A completely automatic system for programming and recording oil well production and tests has been introduced by Fischer & Porter and is described in a detailed brochure published by the company. The brochure includes detailed discussions of the production operations recorder and the well test programmer-recorder as well as flow diagrams, example installations, readout systems, and component descriptions. *Fischer & Porter Company.*

Circle number (36) on reply card.

New Bow Design

Levingston Shipbuilding Company has published a brochure to describe the company's new barge bow design. The new design facilitates construction and repair in that all bottom and side plate sections are absolutely flat, without compound curves, warps, twists, or other distorted shapes. All lines in the rake are straight and the vee is increased, reducing resistance to tow by providing comparatively sharp water-lines and a constant entrance angle throughout full draft of the barge. *Levingston Shipbuilding Company.*

Circle number (37) on reply card.

Offshore Oil Terminal

An illustrated brochure from Offshore Terminal Company, Inc. describes the company's floating offshore oil terminal. Heart of the terminal is a revolving platform to which the tanker moors. Floating hose lines for cargo, bunker oil, and fresh water are attached to platform pipelines connected to a master swivel at the center of the terminal. This design permits ship and hose lines to swing together a full 360 deg with the wind, tide, or current. Each terminal is positioned with 3 or more chains attached to heavy anchors, built to hold even the largest super tankers. *Offshore Terminal Company, Inc.*

Circle number (38) on reply card.

Forged Steel Union Catalog

A new forged steel union catalog covering the complete line of unions is available from W-S Fittings, H. K. Porter Company. It provides detailed specification data on all types, sizes, materials, and pressure ratings. Copy points out application advantages and features of drop-forged unions. The complete line is illustrated. The catalog also shows the complete line of O-ring flange unions and tongue and groove flange unions. *H. K. Porter Company, Inc.*

Circle number (39) on reply card.

Nylon Valve and Seat

An improved nylon valve and seat for high speed reciprocating pumps has been announced in a new catalog of Line Scale Company. The valve seat is available in 2 corrosion-resistant materials, aluminum-bronze, or stainless steel. Nylon is used as the valve member of the self-contained assembly. The valve and seat have been successfully operated at 520 strokes per min in corrosive oilfield brine in typical waterflood conditions with the pump operating 24 hr per day. *Line Scale Company.*

Circle number (40) on reply card.

Servo Operated Pressure Indicator

A 4-page specification bulletin gives details on Press-I-Cell, a servo-operated precision pressure indicator of compact design suitable for production use or as a lab standard. The device provides absolute accuracy of 1 part in 2000 of full scale in range of 0-4 to 0-30 psi. Also available in ranges to 0-1000 psi with accuracy 1 part in 1000. *Fischer & Porter Company.*

Circle number (41) on reply card.

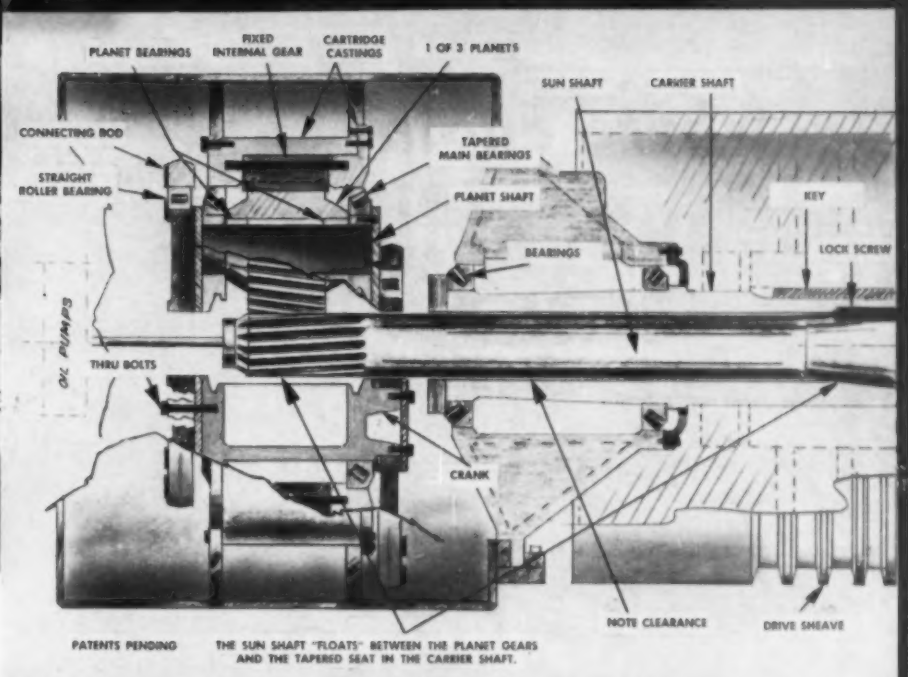
Ductile Iron Products

A new 36-page illustrated catalog describes the complete line of ductile iron products manufactured by the American Cast Iron Pipe Company. Catalog gives technical information including grades, specifications, dimensions, and weights, uses and applications. Typical applications include underground piping, industrial piping, well casing, tanker piping, industrial rolls and component parts for hydraulic cylinder assemblies and industrial machinery. *American Cast Iron Pipe Company.*

Circle number (42) on reply card.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

A series of 8,000 to 10,000 foot wells in Gulf Coast and Southwest Texas show improved penetration and savings in bits.



PATENTS PENDING

THE SUN SHAFT "FLOATS" BETWEEN THE PLANET GEARS AND THE TAPERED SEAT IN THE CARRIER SHAFT.

Consider these EXCLUSIVE ADVANTAGES OF THE WHELAND HP-16000 SLUSH PUMP

WHELAND DUPLEX POWER SLUSH PUMP, 7¾" x 16", 600 HP at 65 RPM

U. S. Patent 2,649,988 and 2,717,186. Other patents pending.

Planetary Gears

Compact. All working parts contained BETWEEN the piston centers. The gear cartridge assembly easily accommodates big bearings for added life. All pumping loads carried through connecting rods to the power end are contained within the circles of the gear cartridge. Eliminates parts subject to deflection and fatigue type loads, and maintains alignment of connecting rods and bearings.

Cylindrical Crossheads

Piston-like cylindrical crossheads operating in honed cylinders are engineered to give permanent perfect alignment in every direction.

Floating Input Shaft

The sun or input shaft floats between the mesh of the three planet gears and the tapered seat in the carrier shaft for even distribution of the load. All loads from the pull of the belts and weight of sheave are carried into the steel housing independent of the sun shaft. Hence, the sun shaft transmits only the torque load to drive the pump.

Small Sheave

6.8 to 1 gear reduction permits small sheave. Note overhanging flange turned toward the pump. Pump may be driven from either side.

WHELAND

ROTARY DRILLING MACHINERY

THE WHELAND COMPANY

CHATTANOOGA, TENNESSEE, U.S.A.

DRAW WORKS • SLUSH PUMPS • ROTARIES

CROWN BLOCKS • TRAVELING BLOCKS • SWIVELS

DOMESTIC DISTRIBUTORS: INDUSTRIAL SUPPLY COMPANY, INC.—Main Office: Wichita Falls, Texas • HOUSTON OIL FIELD MATERIAL COMPANY, INC.—Main Office: Houston, Texas • JONES AND LAUGHLIN STEEL CORPORATION, SUPPLY DIVISION—Main Office: Drawer 2481, Tulsa 2, Oklahoma.

EXPORT DISTRIBUTORS: LUCEY EXPORT CORPORATION—233 Broadway, New York 7, New York—Broad Street House, London, E. C. 2, England.

where engine **dependability** *is vital!*

the only lubricant that has
over 35 years of proven superiority... a record of less costly maintenance, "down time", stoppages and repairs than any other make.

MARVEL extra-fine lubricant is specifically designed to keep engines at peak efficiency under all the "engine-killing" conditions...in an oil field.

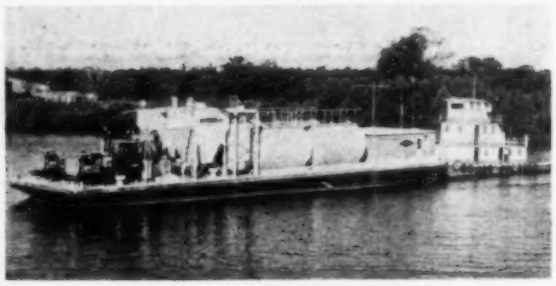
INSTALL A MARVEL INVERSE OILER

TO BE SURE OF "ROUND-THE-CLOCK" PROTECTION.
Feeds MARVEL Mystery Oil in exact proportion to engine speed and load.

Contact your jobber or Oil Well Supply House

MARVEL DIVISION
EMEROL MFG. CO., Inc. • 331 North Main Street, Port Chester, N. Y.

SERVICE BARGES JOIN LOUISIANA COAST FLEET



The Dowell Division of The Dow Chemical Company has introduced two new service barges which will provide cementing and pumping services for operators in the Terrebonne and Tembalier Bay areas on the Louisiana Gulf Coast. The barges were built by McDermott Fabricators in their Morgan City yards.

Each of the barges, measuring 120 ft long by 30 ft wide, is equipped with a complete cementing station, including four bulk cement storage tanks, each with a 1000-ft capacity. Dry cement controlled blending equipment is part of the bulk cement storage system. There are two blended cement bins that provide storage for 1200 sacks of dry, blended cement.

The barges have the latest type of air slides and pumps for handling dry cement which is pumped from various storage tanks to the weigh batcher-blender and slurry mixer by a pneumatic system. There is also a bucket-type elevator for transferring various dry addition agents to the dry cement weigh batcher-blender.

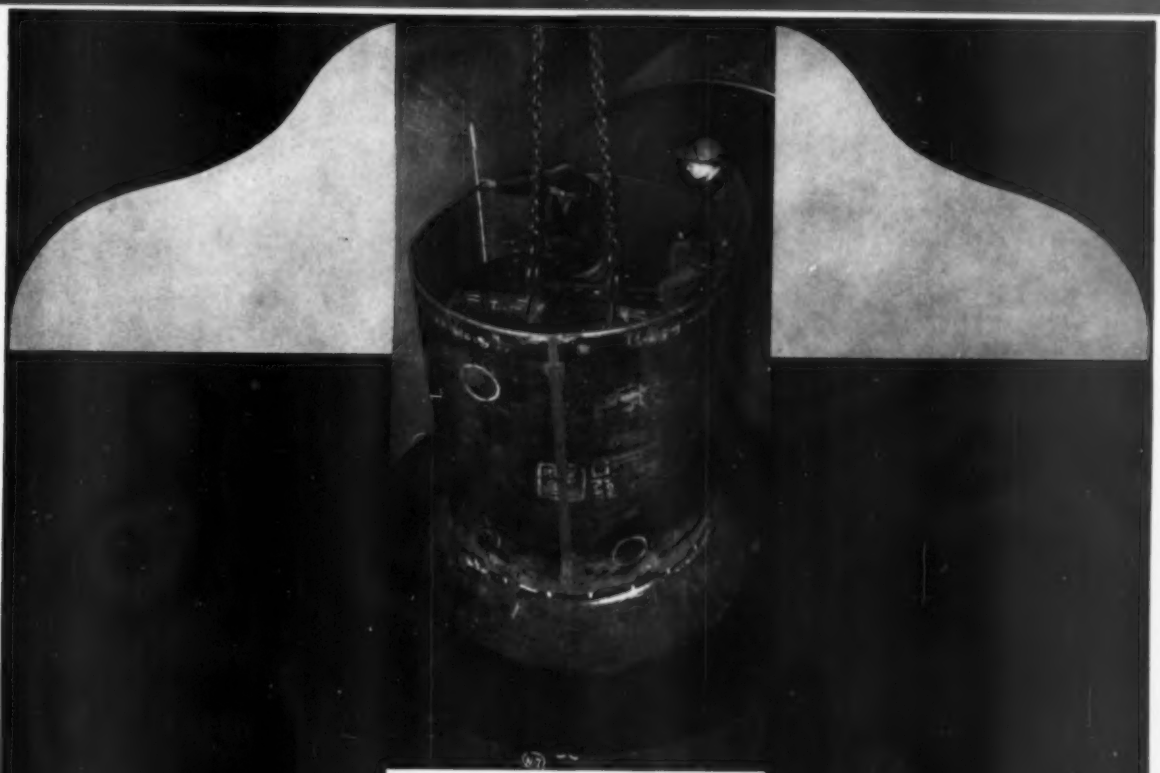
Other features of the new cementing units are the Dowell-designed densitometers. These instruments record the density of the cement slurry electronically as it is delivered from the blender tank to the cementing pumps. This provides the operators with a continuous record of the slurry weight as it is being delivered to the well. The record becomes a permanent part of the cementing report. When desired, the slurry weight can be changed during the cement job by a single adjustment from the operator's control panel.

In addition to cement storage tanks, each barge is equipped with a 2000-gal acid storage tank to provide for chemical treatments in conjunction with cement jobs.

Triplex pumps, 4½ in. by 8 in., are standard equipment on the barges. These high pressure pumps are powered by two twin 308 hydraulic horsepower diesel engines through torque converters and transmissions. The transmissions are operated pneumatically from the operator's control panel.

All major controls for handling the barge equipment are air operated. They are centrally located on a platform from where the operator can observe and control all operations with a maximum of efficiency. Other interesting features of the barges are air-conditioned crew quarters, two-way radio communications with the company's land base at Houma, and a 220-v electrical generating system to operate lights, air conditioning, refrigeration, galley, and fresh-water pumps. Adequate fresh water storage is provided for the crew.

Leased tugs will be used to move the new barges. A third barge, now under construction, will be used only to transport bulk cement.



MADE TO ORDER

In a variety of combinations, chemical plant and oil refinery equipment require alloy steels: Some components with stainless parts . . . some completely stainless . . . some with a number of other alloys, but all capable of specific customized functions.

Whatever your requirement for Specialty, Sun Ship is prepared to custom-construct pressure vessels, plate work, autoclaves and machinery . . . each to specifications and requirements . . . each made to order.

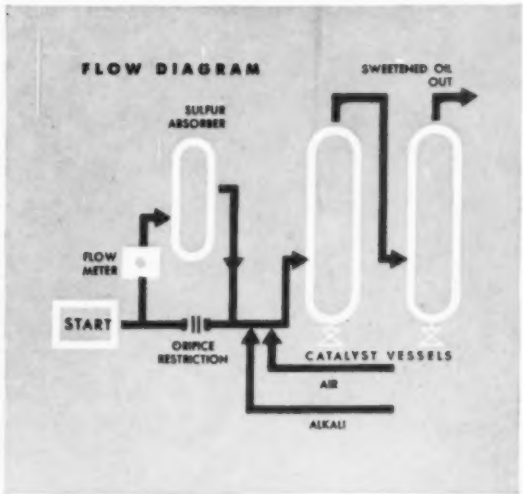
Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • SINCE 1916 • CHESTER, PA.

PRODUCT IMPROVEMENT WITH

PETRECO



IF SWEETENING IS ONE OF YOUR REFINERY PROBLEMS...

these facts about PETRECO* BENDER Catalytic Sweetening† may show you the answer:

LOW OPERATING COSTS: The average treating costs of Petreco Bender treating units are about 0.5 cents per barrel. Copper chloride or doctor treating costs, exclusive of amortization, generally exceed 1.0 cents per barrel. *The value of the volume loss in doctor treating alone often exceeds the total operation and amortization costs of Petreco Bender catalytic sweetening.*

SWEET NON-CORROSIVE PRODUCT: As compared to doctor treating, less sulfur is used, resulting in the delivery of a consistently non-corrosive product. *The use of less sulfur also lessens octane loss.*

ELIMINATES AIR AND WATER POLLUTION: Processing is in a closed system, eliminating air pollution and the attendant safety hazards. This eliminates open batch type agitators, thereby assisting in safety programs. *There is no "black strap" carry-over or carry-under to contaminate waste disposal systems.*

The product from the Petreco Bender unit is low in trace metal ions. Where a water wash is required to meet local product specifications, emulsion problems are not encountered due to the cleanliness of the Bender treated oil.

The only spent alkali withdrawn from the Bender unit each day is the small amount not consumed in the process.

HIGH YIELD: There is no volume loss in the system other than sampling and spillage. The volume loss in other sweetening processes is the greatest expense factor.

CONTINUOUS REGENERATION NOT NECESSARY: The catalyst retains its activity for long periods of time. This is made possible by the continuous addition of small quantities of air and alkali. Catalyst life without reactivation is usually two years or more. *Two Petreco Bender plants have been operating for over three years without any reactivation of the original catalyst.*

LOW INSTALLATION COST: *Unit cost for new equipment is comparatively low, ranging from $15 to $30 per barrel of daily throughput capacity.* If existing vessels are available and appropriate for conversion, this cost can be substantially reduced. Very often the charge may be taken directly from a distillation unit with existing pumps, exchangers and instrumentation, reducing the installation cost further.

SMALL TREATING AREA REQUIRED: Where ground areas are congested, the area occupied by any treating unit is of great importance. The plot dimensions for a 5,000 bpd Petreco Bender unit, for example, would be approximately 20′ x 35′.

† *For middle range distillate streams such as kerosine, stove oil, light gas oil, No. 2 fuel oil, coker naphtha and catalytic gasoline.*

*PETRECO *is a registered trademark of Petrolite Corporation.*

BBG-1

PETROLITE CORPORATION

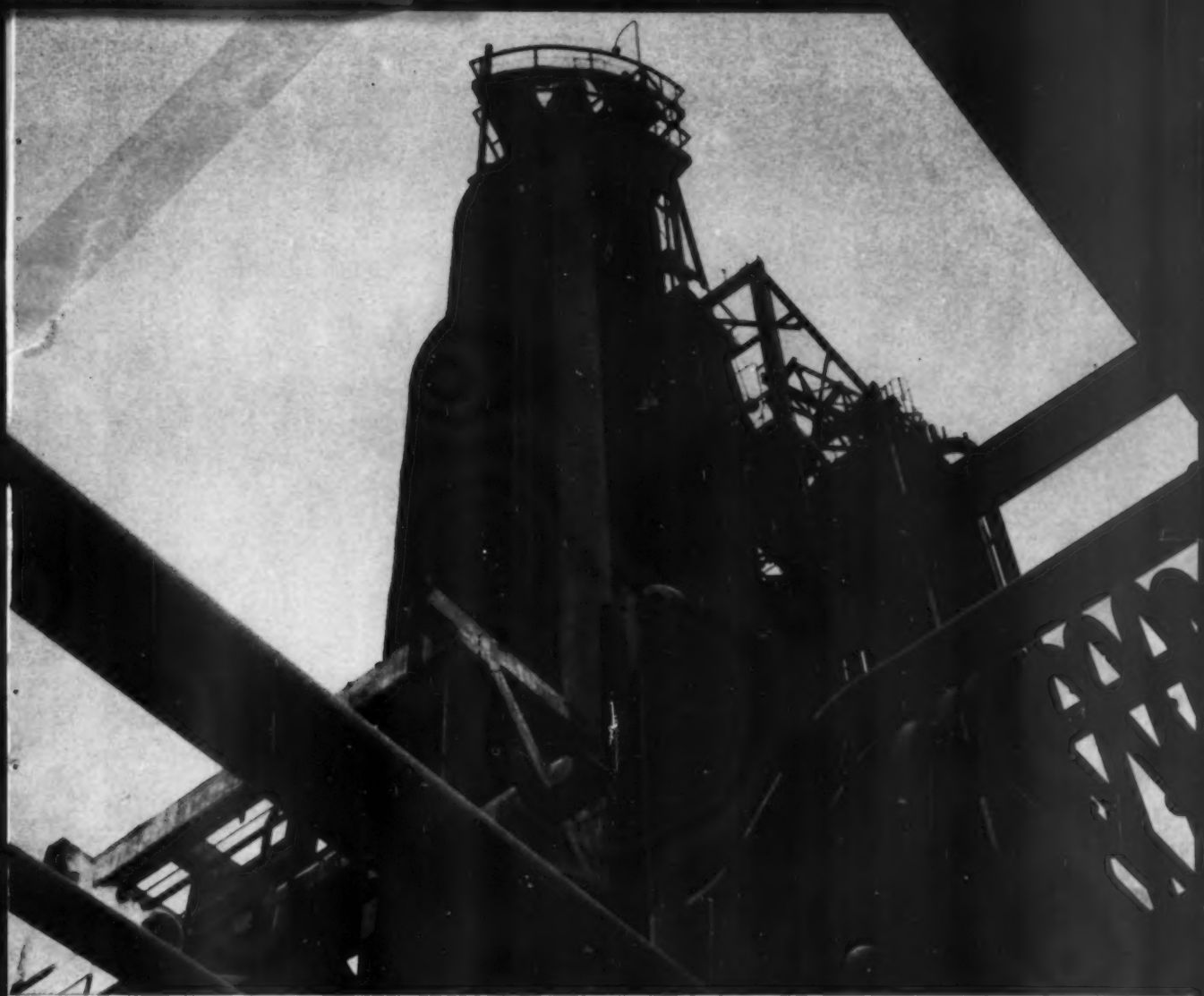
PETRECO DIVISION

3202 South Wayside Drive (P.O. Box 2546), Houston 1, Texas
1390 East Burnett Street (P.O. Box 7216), Long Beach 7, California

CANADA: Petreco, 4528 Stanley Drive, Calgary, Alberta
COLOMBIA: South American Petrolite Corporation, Calle 19, No. 7-30, Office 807, Bogota
ENGLAND: Petrolite Limited, 46 Mount Street, London, W. 1.
VENEZUELA: South American Petrolite Corporation, Hotel Avila, Caracas

REPRESENTATIVES

BRAZIL: WERCO, Ltda., Rua General Gurjao 326, Rio de Janeiro
ITALY: O. Wagner, 149 Via Nemorense, Apt. 1, Rome, Italy
JAPAN: Chiyoda Chemical Engineering and Construction Company, Ltd., Tokyo Bldg., No. 3, Marunouchi 2-Chome, Chiyoda-Ku, Tokyo, Japan
KUWAIT: F. N. Dahdah, Box 1713, Al Kuwait
MEXICO: R. E. Power, Sierra de Mijes, No. 125, Mexico D. F.
NETHERLANDS: F. E. C. Jenkins, Hoefbladlaan 134, The Hague
TRINIDAD: Neal and Massy, Ltd., Port of Spain, P. O. Box 544



Stainless Steel beats high temperature sulfide corrosion

AT GULF OIL'S
PORT ARTHUR, TEXAS, REFINERY

These atmospheric and vacuum distillation units, until just recently, processed about 32,000 barrels of West Texas sour crude per day. The atmospheric tower, barely visible in the right background, fractionates the crude to produce wet gas, straight run gasoline, light naphtha, light and heavy furnace oil, atmospheric gas oil and reduced crude. The vacuum tower in the center fractionates the reduced crude into light and heavy vacuum gas oil and bottoms.

Stainless Steel is the most practical material to withstand high temperature sulfide corrosion in the lining of these units. Operating temperature in the bottom shell of the atmospheric tower is 600° F. and in the vacuum tower it's 680° F. The 5/64" Type 405 Stainless Steel lining in the vacuum tower has been in service for ten years, and it hasn't shown one sign of failure! The atmospheric tower was not originally designed with Stainless and later was found to be corroding so badly that a Type 410 Stainless Steel lining was installed in the lower part of the tower.

It pays to design with the right material from the start. If you need corrosion resistance and strength at high temperatures, there is no material that can match the performance and economy of Stainless Steel. Order USS Stainless Steel through your U. S. Steel representative or your local Steel Service Center.

USS is a registered trademark

United States Steel Corporation—Pittsburgh
American Steel & Wire—Cleveland
National Tube—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

USS United States Steel

Sparking sample for spectrographic determination of phosphorus.

Announcing new methods for rapid determination of phosphorus in gasoline

Ethyl Research develops spectrographic and colorimetric procedures

In recent years, phosphorus compounds have been used extensively as gasoline additives to combat surface ignition and spark plug fouling. Indications are that phosphorus deposit modifiers will be even more important in the future. This has created a need for rapid methods to determine phosphorus in gasoline.

Ethyl's Detroit Research Laboratories have developed two analytical procedures to satisfy this need. One of these is spectrographic and the other colorimetric.

Both procedures apply to a wide variety of phosphorus compounds. And they can be used effectively on gasolines containing additives such as tetraethyllead, antioxidants, dyes, and metal deactivators.

Spectrographic Method

Phosphorus concentrations* of 5 to 75 mg. per liter of gasoline can be determined by the spectrographic method with a standard deviation of 0.8 mg. per liter. A single phosphorus determination can be made in 30 minutes; a two-man team can make 70 such determinations per day.

The gasoline is analyzed without pretreatment except for adding a radiation buffer and an internal standard.

The buffer solution, consisting of 60 percent dimethylformamide and 40 percent isopropanol, improves the phosphorus line intensity and also reduces the effects of base stock and additives. Triphenylarsine, added to the buffer as

**Phosphorus concentration is frequently stated as "theories of phosphorus". A theory is the weight ratio equivalent to two atoms of phosphorus to three atoms of lead.*

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

the internal standard, further reduces the effects of variations in sample and additive composition.

An inert atmosphere of argon prevents sample ignition. The argon also enhances the intensity of the phosphorus line.

Analytical curves are plotted to give phosphorus concentrations in units of grams per liter, or as "theories of phosphorus" for a given tetraethyllead concentration.

One curve can be used for samples containing commonly used phosphorus additives. Separate curves are needed for samples containing more volatile phosphorus compounds such as trimethyl phosphate, triethyl phosphate, and dibutyl hydrogen phosphate.

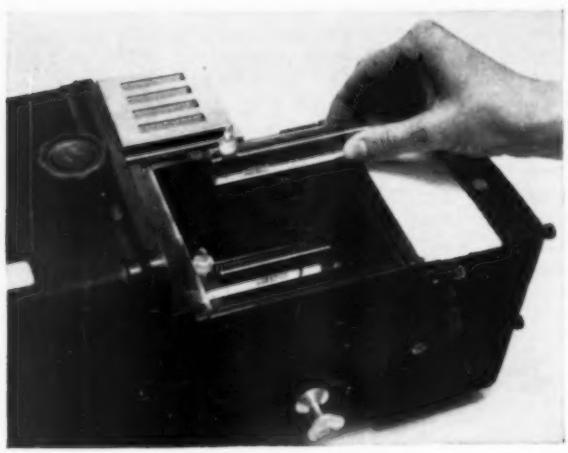
A correction is required for samples containing manganese.

Colorimetric Method

The colorimetric procedure is slower than the spectrographic method but more accurate. It can be applied to gasoline containing from 5 to 50 mg. of phosphorus per liter with a standard deviation of 0.5 mg. per liter. An hour is needed for a single determination; 24 can be made per man day.

The fuel sample is adsorbed on zinc oxide and ignited to oxidize the organic phosphorus. It is subsequently converted to the orthophosphate ion by dissolving in sulphuric acid. In this form phosphorus is readily measured in the presence of zinc, using a molybdenum blue method. Color obtained is stable and reproducible.

Ethyl's experience with a large number of gasolines containing a variety of antioxidants, dyes and metal deactivators has shown that these additives do not interfere with the determination; neither does manganese added to gasoline as (methylcyclopentadienyl)manganese tricarbonyl.



Inserting sample for colorimetric procedure.

Comparison of Spectrographic and Colorimetric Methods

	Spectrographic	Colorimetric
Sample size, ml.	4	1
Elapsed time for one determination; minutes	30	60
Determinations per man-day	35	24
Concentration range, mg./liter	5-75	5-50
Standard deviation, mg./liter	0.8	0.5
Base stock effect	none	none
Phosphorus additive effect	Additional calibration needed for volatile compounds	none
Manganese interference	Correction required	none

How Ethyl Research can help you

Copies of the paper, "Rapid Determination of Phosphorus in Gasoline," presented at the recent API Division of Refining meeting, are available through your Ethyl Representative. It is a detailed description of the analytical procedures outlined here.

The need for rapid methods to determine phosphorus in gasoline has arisen from the widespread acceptance of phosphorus additives as deposit modifiers. Ethyl has available three such additives. Two of these are free from any patent complications. Your Ethyl Representative will be glad to supply you with full details.

ETHYL
ANTIKNOCK COMPOUND
ETHYL CORPORATION

ETHYL CORPORATION
New York 17, N. Y.

Ethyl Corporation of Canada Limited, Toronto
Ethyl USA (Export) New York 17, N. Y.

RESEARCH LABORATORIES
Ferndale 20, Detroit, Michigan
San Bernardino, California

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

A REPORT ON . . .

Continuous Thermocontact Treatment

Here is a discussion by a leading consultant on the treatment of oil stacks by a high temperature carrier

Dr. E. R. Smoley
Consultant
Scarsdale, New York

IN THE EARLY 1940's, development work was started using a solid heat carrier for treating oil stocks leading to the use of coke formed in the process for this heat carrier in 1948. Work was carried out in two directions: (1) at 950 to 1000 F for the production of distillates with application in the oil refining industry, and (2) at 1200 F and higher temperatures for the production of gas containing high percentages of unsaturated hydrocarbons for use in the petrochemical industry.

1. Refinery Application

The studies made of the kinetics of combustion of coke and evaluation of the process variables involved in these processes such as coking temperatures versus time, weight ratio of circulated coke versus charge, coke strength versus residence time, yields of residues versus time of coking, heat consumption per unit weight of charge, and the coke required for supplying this heat with recycling of heavy fractions, as well as the operation of the many pilot plant units should have been helpful in the design of the large commercial unit.

This unit, now under construction, is designed to circulate by steam lift 1400 tons per hour of coke, has a reactor diameter of 15+ ft carrying 200 tons of coke, and a coke heater diameter of 18+ ft holding about 130 tons of coke.

Reportedly the design utilizes a dry coke heat carrier stream eight inches thick which moves along the reactor walls to protect these walls from being wetted by charge stock thus preventing coke formation on these reactor walls and the resulting formation of coke agglomerates and serious bridging effects across the reactor cross section. The amount of this dry protecting coke heat carrier was about equal to the reaction coke stream for small pilot plant units and is calculated to be about one-third of the main stream for large units. At a 10 to 1 weight ratio of reaction coke to charge the total coke circulation to charge would be about 14 to 1 and the coke circulation of 1400 tons per hour on the large unit under construction would furnish about 1000 tons per hour of reaction coke. This is the equivalent of a charge capacity of 14,000 to 16,000 bbl per day depending on the feed gravity. Results obtained from this operation will be most interesting to world-wide industry.

TABLE 1. Coker Construction.
(From 1954 to 1959)

Company	Location	Unit Type	Capacity
The Carter Oil Co.	Billings, Montana	Fluid	3,800
D-X Sunray	Duncan, Oklahoma	Delayed	7,000
Texaco, Inc.	Amarillo, Texas	Delayed	3,500
Texaco, Inc.	El Paso, Texas	Delayed	3,500
Union Oil Co. (Calif.)	Santa Maria, California	Delayed	18,700
Cities Service	East Chicago, Indiana	Delayed	15,000
Canadian Petrofina, Ltd.	Montreal, Quebec	Fluid	3,800
Great Northern Oil	Pine Bend, Minnesota	Delayed	10,400
Hancock Oil Co.	Long Beach, California	Delayed	6,000
Mid-Continent Petroleum	West Tulsa, Oklahoma	Delayed	7,000
Standard (Indiana)	Wood River, Illinois	Delayed	8,500
Eastern States Petroleum	Houston, Texas	Delayed	13,000
Aurora Gasoline Co.	Detroit, Michigan	Fluid	4,000
Consumers Co-Op	Coffeyville, Kansas	Delayed	8,440
D-X Sunray	Tulsa, Oklahoma	Delayed	7,000
Tidewater Oil Co.	Associated, California	Fluid	42,000
Petroles Mexicanos	Ciudad Madero, Mexico	Delayed	
American Oil Co.	Yorktown, Virginia	Delayed	15,000
Lake Charles Chemical Co.	Lake Charles, Louisiana	Delayed	10,000
Bankline Oil Co.	Bakersfield, California	Fluid	4,000
American Gilsonite	Grand Junction, Colorado	Delayed	4,000
Continental Oil	Wichita Falls, Texas	Delayed	
Socony-Mobil	Paulsboro, New Jersey	Delayed	19,000
Consumers Co-Op	Regina, Saskatchewan	Delayed	3,000
Kosa Oil	Iwakuni, Japan	Delayed	4,500
Tidewater Oil Co.	Delaware City, Delaware	Fluid	42,000
Pontiac Eastern Corp.	Hattiesburg, Mississippi	Fluid	4,800

Editor's Note: This is a discussion on Paper 29, Section III of the Fifth World Petroleum Congress as given by Dr. E. R. Smoley. Dr. Smoley prepared this discussion from the original paper by the USSR upon the request of the Congress and presented his discussion June 5, 1959.

Continuous contact coking in the United States refining industry[1] here have reported operations of a 50 bbl per day charge pilot plant, a 100 bbl per day semi-commercial unit and a 1000 bbl per day commercial plant with reactor diameter 8 ft and heater diameter 7 ft 6 in., coke circulation 100 tons per hour. A completed design for a plant with a 2500 bbl per day charge, with reactor and reheater diameter 14 ft, coke circulation of 250 tons per hour and an investment of $1,600,000 was reported in 1953. It is indicated that more information on the economics of this process is desirable.

During the past five years, however, no commercial continuous contact coker has been built for refinery coking. Some units have been built in Europe for production of gas. Seven fluid bed coking units with charge rates of 3800 to 42,000 bbl per day charge[2,5] have been built during the past period of five years and are now operating. Some forty delayed coking units with sizes up to 800 tons per day coke production are now in operation and about 20 have been erected during the past five years[3] as shown by Table 1.

2. Petrochemical Application

Russians show sketches of two pulverized coke contact processes for the production of unsaturated hydrocarbons. This involves the treatment of oils at high temperatures (1200 to 1500 F) using high linear velocities and very short time (less than one second). The coke is heated directly by short time contact (0.1 sec.) moving down at low enough temperatures to form practically no carbon monoxide. This work was on a pilot plant scale. The upflow scheme also on a pilot scale used heat carrier particles about 0.25 to .50 mm diam with high heat carrier concentrations and temperatures 1400 to 1600 F and contact time of .2 to .4 sec. The Hoechst continuous coking process in a commercial unit[4] preheated their coke by heat exchangers for the manufacture of unsaturateds and coke in order not to burn away too much coke.

Bibliography

1. *The Lummus Continuous Contact Coking Process*, API November 9, 1953, V. Mekler, A. H. Schutte, T. T. Whipple.
2. *Fluid Coking of Residua*, API November 9, 1953, A. Voorhies, Jr. H. Z. Martin.
3. *New Developments and Techniques in Delayed Coking*, API May 1959, V. Mekler, M. E. Brooks.
4. *The Hoechst Continuous Coking Process*, 1955 4th World Petroleum Congress (Rome), H. Kreksler.
5. *The Fluid Coking Process — Commercial Experience to Date*, 1959 5th World Petroleum Congress (New York), James McDonald, C. O. Rhys, Jr.

★ ★ ★

New Developments and Techniques in . . .

DELAYED COKING

Valentine Mekler **Maurice E. Brooks**
The Lummus Company, New York City, New York

THE REFINING INDUSTRY has been plagued by the problem of residual fuel oil which has become a byproduct in the sense of producing less sales revenue for refiners than the cost of crude oil. This situation has been further complicated by competition from other fuels, fluctuations in demands, and local oversupply.

With the demand for gasoline and distillate fuels increasing rapidly and the low price for residuals, most refiners in the United States have found it desirable to reduce the output of residual fuel. This has been accomplished by going deeper into the barrel by such processes as viscosity breaking, vacuum distillation, propane decarbonizing, and coking. Coking of residuals has proven to be an important process to reduce residual production. As shown in Table 1, as of March 1959, 43 coking units were in operation in the United States with a charge capacity of approximately 480,000 bbl per stream day producing 15,400 tons per day of coke.

One of the most pronounced and consistent trends since the end of World War II has been the decreased demand for residual fuel, as shown in Fig. 1. It is believed that this trend will become even more pronounced in the next decade.

Adapted from a paper presented by the authors during the 24th Midyear Meeting of the American Petroleum Institute's Division of Refining, New York, May, 1959.

TABLE 1 [1a] — Production Capacity of Coking Units in the United States as of March 1, 1959

Coker charge, bbl per stream day	480,000
Number of units	43
Coke production, tons per day	15,400
Average per cent of Conradson carbon	10.5
Coke yield, per cent by weight	18.3
Coke — per cent by weight of crude oil	4.1

TABLE 2 — Ratio of Product Sales Price to Crude-Oil Purchase Price

	Period 1937-1956[2]				
	Minimum Ratio	Maximum Ratio	Average Ratio	1956	1958[4]
Product:					
Gasoline	1.72	2.39	2.01	1.74	1.61
Kerosine	1.50	1.82	1.64	1.63	1.49
Distillate fuel oils	1.27	1.87	1.42	1.40	1.28
Residual fuel oils	0.55	0.96	0.74	0.79	0.65

The continued expansion of the natural-gas industry will capture more of the market presently held by residual fuel.

Residual supply and demand are not always in balance uniformly throughout the country, forcing some refiners to build coking units in order to remove limitations in crude-oil runs caused by unsalable fuel oil and limited tankage. In addition, the unattractive return from residual fuels has acted as an incentive to upgrade the residual fuels into more valuable light products. The close spread between product and crude-oil prices, as shown in Table 2, has made it attractive to the refiner in some cases to consider coking units. In 12 inland states, the crude-oil runs amount to 29 percent of the total refining capacity, while producing 52 percent of the total coke production. Thus, these states plus California, which is a special case, produce 75 percent of the total coke while refining only 43 percent of the total crude oil. These factors have actually resulted in recent years in imported residual fuel becoming an important supply factor, as can be seen in Fig. 1. Imported residual fuel, which amounted to only 6 percent of the total demand in 1937 and 13 percent in 1947, jumped to 24 percent in 1957. Therefore, while the demand for residual fuel has decreased from 25 percent of crude oil in 1930 to 16 percent in 1958, production has actually decreased to approximately 12 percent in 1958.

Until a commercially attractive process is successfully developed to hydrogenate residual fuel, the delayed coking process will continue to be economically attractive. It can be predicted, based on the rate of growth of various petroleum products, as shown in Fig. 2, that additional coking capacity

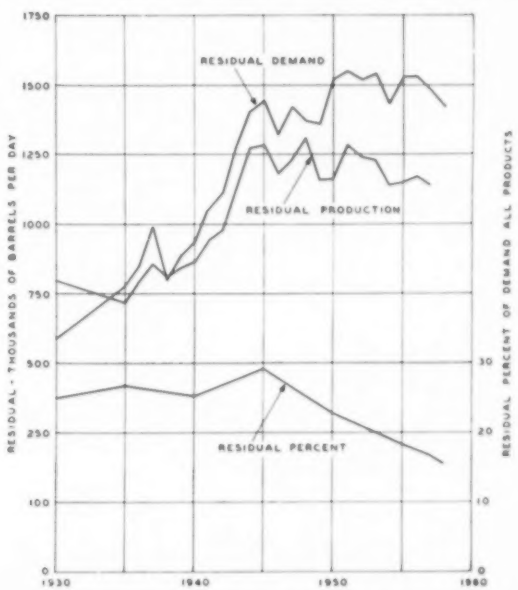


FIG. 1. Demand for residual fuels in the United States.[2]

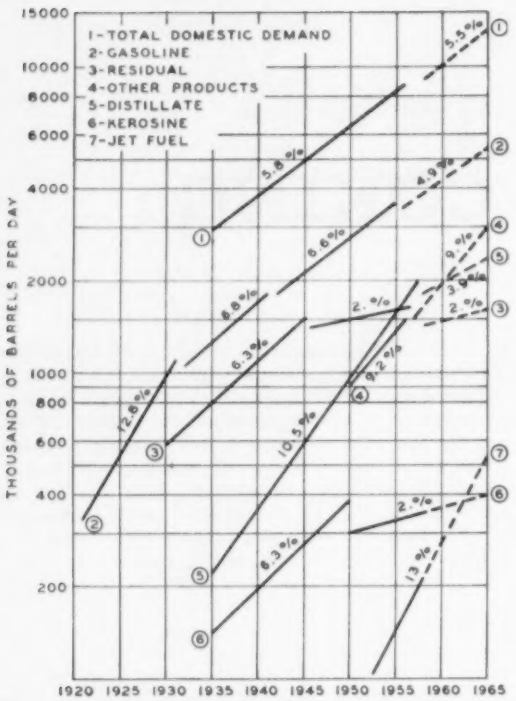


FIG. 2. Demand trend curves for petroleum products in the United States,[5] percent increase per year compounded.

will have to be built in the United States at an accelerated pace.

As can be seen in Fig. 2 and predicted by recent surveys,[6,7] a slower growth for gasoline is predicted. While the amount of coker gas oil presently charged to catalytic cracking units is not a large percent of fresh feed, amounting to approximately 8 percent in 1958, nevertheless, increased production of coker gas oil from new cokers coupled with a slower growth of gasoline might point to the economics, in some cases, of combining delayed coking with thermal cracking of heavy coker gas oil to produce a maximum of diesel or No. 2 fuel. Typical yields for such an operation are shown in Table 3.

Since, for the foreseeable future at least, the delayed coking process will remain in the forefront and with the indications of considerable expansion of coking capacity in the United States, this appears to be an opportune time to review the present art of the delayed coking process, as well as indicate how attention to the design of the critical equipment, such as the heater and the coke drums, has permitted this process to handle heavier charge stocks while attaining remarkable on-stream time efficiencies.

TABLE 3 — Yields of Combination Coking and Thermal Cracking

	Yields (percent by weight)
C_2 and lighter	6.8
C_3-C_4	6.1
Light gasoline	12.5
Heavy gasoline	10.1
Cracked diesel oil	37.9
Fuel oil	8.7
Coke	17.9
Total	100.0

Physical Properties of Streams

	Reduced Crude-Oil Charge	Light Gasoline	Heavy Gasoline	Cracked Diesel Oil	Fuel Oil
Gravity, deg API	17.3	79.0	53.0	38.0	12.5
Reid vapor pressure, psi	—	5.5 to 7.5	—	—	—
ASTM end point, deg F	—	226	365	662	—
Cloud point, deg F	—	—	—	+5	—
Conradson carbon, percent by weight	9.2	—	—	—	—

Process

A simplified discussion of delayed coking and the fractionation section shows the residual charge fed directly to the bottom of the fractionator where material lighter than the end point of desired gas oil is flashed off. The reduced feed combined with the recycle is pumped from the bottom of the fractionating tower to the coking heater. The effluent from the coking heater enters one of the two coke drums. Under the time-temperature conditions in the coke drums, coke is formed and accumulates in the vessel, and the coke-drum overhead vapors enter the lower section of the fractionating tower for separation into gas, gasolines, gas oils, and recycle stock.

Process Variables

Process variables in coking, such as feedstocks, product specifications, recycle ratio, and operating conditions, and their effect on the performance of the unit are just as important as variables in any other petroleum process.

A. Feedstock

Prior to the demand for a greater recovery of the gas oil for catalytic cracking per barrel of crude oil, the feedstock to the delayed coking unit normally was an atmospheric-reduced crude oil not exceeding 10 to 12 percent by weight of Conradson carbon and representing approximately 30 percent on the crude oil.

However, with the technological improvements of catalytic cracking and its ability to process heavy gas oil, the bottoms from the atmospheric tower were vacuum flashed to recover maximum gas oil suitable for catalytic cracking. The depth of vacuum operation was governed by permissible carbon and metal content in the gas-oil charge to catalytic cracking. The petroleum vacuum pitch thus produced contained in the order of 25 percent by weight of carbon residue. Such heavy feedstocks had not previously been encountered in delayed coking, and they presented a problem in the designing of critical equipment, particularly the heater which must stay on line for long periods of time without premature coking and forced shutdown.

Due to improvements in the design and operation of the major equipment, to be discussed later, modern coking units are processing successfully a variety of heavy residual stock. In addition to petroleum stocks, delayed coking units can process such residual stock as shale oil, Athabasca bitumen, gilsonite, coal-tar pitch, and other stocks with Conradson carbon content as high as 50 percent by weight.

B. Product Specification

The delayed coking unit is a very flexible tool in the refinery and is capable of processing and producing a variety of feedstocks and products as required by changes in the refinery operations.

With the advance of catalytic reforming and catalytic hydrogenation processes, it was found that the effluent from the coking unit, if properly fractionated into narrow cuts, could be upgraded more economically by further processing. As a result, coking units now are designed to fractionate the effluent from the coke drum into as many as seven products, such as C_2 and lighter gas, LPG,* BB† fraction, light gasoline, heavy gasoline for catalytic reforming, light gas oil for treating to produce either diesel oil or furnace oil, and heavy gas oil to catalytic cracking and coke. In some cases, a fraction between the heavy gasoline and the light furnace oil is also withdrawn as slop. Typical specifications of delayed coking products are given in Table 4.

* Liquefied petroleum gases.
† Butane-butene.

TABLE 4 — Typical Specifications of Delayed Coking Products

	Venezuelan Charge Stock	Light Gasoline	Heavy Gasoline	Light Gas Oil	Heavy Gas Oil	Naphtha Slop	Total Gas Oil	Venezuelan Coke	Mid-Continent Coke	German Coke	Illinois Coke	California Coke
Gravity, deg API	7.4	76.9	49.9	36.2	22.3	42.5	27.7	—	—	—	—	—
Reid vapor pressure, lb	—	10.5	—	—	—	—	—	—	—	—	—	—
ASTM distillation, deg F:					Vacuum		Vacuum					
Initial boiling point	—	ASTM 97	ASTM 243	ASTM 388	Engler 545	ASTM 356	Engler 432	—	—	—	—	—
5-percent point	—	114	259	418	592	390	481	—	—	—	—	—
10-percent point	—	118	264	431	614	403	495	—	—	—	—	—
20-percent point	—	123	274	436	645	414	527	—	—	—	—	—
30-percent point	—	128	282	445	670	416	555	—	—	—	—	—
40-percent point	—	133	290	455	695	418	585	—	—	—	—	—
50-percent point	—	140	302	472	725	422	623	—	—	—	—	—
60-percent point	—	148	313	484	755	427	665	—	—	—	—	—
70-percent point	—	158	326	496	782	433	717	—	—	—	—	—
80-percent point	—	169	342	511	835	456	779	—	—	—	—	—
90-percent point	—	183	360	536	885	466	852	—	—	—	—	—
95-percent point	—	194	371	565	915	477	895	—	—	—	—	—
Final boiling point	—	201	396	611	950	494	950	—	—	—	—	—
Sulfur, percent by weight	2.76	0.13	0.25	1.15	1.57	0.42	1.42	3.7 to 4.6	1.6 to 1.8	1.7 to 1.9	2.1 to 2.3	1.0 to 2.0
Flash (Penaky-Martens), deg F	—	—	—	165	—	—	—	—	—	—	—	—
Conradson carbon, percent by weight	19.6	—	—	0.03	0.30	—	0.17	—	—	—	—	—
ASTM octane number (D 908, Research Method), without TEL addition	—	77.5	64.0	—	—	—	—	—	—	—	—	—
Moisture, percent by weight (air dried)	—	—	—	—	—	—	—	—	0.5 to 1.2	0.1	0.1 to 0.5	—
Volatile matter, percent by weight	—	—	—	—	—	—	—	10 to 14	10 to 13	8 to 9	9 to 12	9 to 14
Carbon, percent by weight	—	—	—	—	—	—	—	—	86 to 90	90 to 92	87 to 91	—
Ash, percent by weight	—	—	—	—	—	—	—	0.4 to 1.0	0.2 to 0.5	0.2 to 0.5	0.7 to 0.8	0.2 to 0.7
Density, lb per cu ft	—	—	—	—	—	—	—	53 to 65	50 to 55	50 to 55	60 to 65	—

Table 5 shows typical charging stocks, operating conditions, yields, and product specifications when processing petroleum residues in commercial delayed coking units, while Table 6 shows the typical result when processing non-petroleum stocks in pilot plant units.

It will be noticed that the relative yields, distribution of products from non-petroleum stocks, are quite different from yields obtained from petroleum stocks.

C. Recycle Ratio

The term "recycle ratio" as applied to fresh feed to the coking units is often misleading, because the distillation, gravity, etc., of the fresh feed may vary considerably, while the distillation of the feed to the coking heater from the bottom of the fractionating tower is approximately the same for the equivalent end point of gas oil produced. Therefore, it is more consistent to apply the recycle ratio not to the total fresh feed to the unit, but to the equivalent fresh feed, which is the total fresh feed minus the material below the end point of gas oil to be produced that normally would be flashed out in the fractionating tower. The combined feed is then defined as the equivalent fresh feed plus the recycle.

When processing heavy residues, the normal recycle ratio in coking units, based on the equivalent fresh feed and producing approximately 950 F end-point gas oil, varies between 0.10 and 0.25 to 1.0. However, when producing light gas oil with an approximate end point of 700 F, the recycle ratio is increased proportionately, and for refractory charge material it may be as high as 0.8 to 1.0 on the equivalent fresh feed.

Typical Analysis of C_5 — 380 F End-Point Fraction

	Percent by Weight
H_2	1.2
C_1	10.1
C_2—	0.8
C_2	7.5
C_3—	3.9
C_3	8.3
C_4—	2.6
C_4	7.4
C_5	6.2
C_6+	52.0
	100.0

When total fresh feed is used in relation to total combined feed to the heater, then the recycle ratio, if the fresh feed is light, will be much smaller. Instead of the normal 30 percent by volume, the recycle may calculate to be 5 percent or even minus 15 percent as shown in Table 5, column 1.

D. Operating Conditions

Operating conditions in delayed coking, such as temperature, pressure, and recycle ratios, vary within a relatively narrow range. The outlet temperature of the coking heater varies between 900 F and 960 F, and coke-drum pressures vary between 15 psig and 90 psig. The choice of operating conditions depends primarily on specifications of the charging stock, products desired, and overall refinery operations. Over 90 percent of existing delayed coking units produce heavy gas oil of approximately 950 F end point and operate at a pressure of approximately 30 psig at the coke drum, at an outlet temperature of the heater of ap-

TABLE 5 — Delayed Coking of Petroleum Residues from Commercial Units

Source of Crude oil	Mid-Continent	Mid-Continent, Illinois Mix	Arkansas	Illinois	Oklahoma	Venezuela	California*
Charge to unit:							
Percent by volume on crude oil	30	—	30	—	—	—	—
Gravity, deg API	20.7	18.9	13.0	12.5	14.0	7.4	12.0
Conradson carbon, percent by weight	—	6.71	15.1	14.8	11.6	19.6	9.6
Sulfur, percent by weight	2.48	0.82	3.0	0.6	1.15	2.76	1.6
Operating conditions:							
Heater outlet, deg F	910	904	914	925	915	920	925
Drum pressure, psig	35	25	30	35	32	25	60
Ratio combined feed to fresh feed	0.85	0.98	1.12	1.25	1.3	1.2	—
Ratio combined feed to equivalent fresh feed	1.30	1.30	1.34	1.25	1.3	1.2	1.30
Yields, percent by weight:							
C_3 and lighter	5.8	6.4	8.1	6.4	7.1	5.6	12.0
Gasoline, C_5—400 F ASTM end point	21.8	—	17.1	21.6	—	17.8	15.7
Light gasoline	—	8.6	—	—	20.5	6.1	—
Heavy gasoline	—	7.2	—	—	—	11.7	—
Light gas oil	56.1	9.9	43.3	46.0	49.5	20.0	35.2
Heavy gas oil	—	51.5	—	—	—	23.7	15.5
Coke	16.3	12.6	31.5	26.0	22.9	32.6	21.6
Product specifications:							
Full-range gasoline end point, deg F	400	—	400	400	—	400	390
Light gasoline end point, deg F	—	300	—	—	380	200	—
Heavy gasoline end point, deg F	—	435	—	—	—	400	—
Light gas-oil end point, deg F	—	611	—	—	—	666	720
Heavy gas oil, deg API	28.2	25.5	27.1	29.0	29.4	22.3	10.1
Vacuum Engler end point, deg F	725	950	—	—	850	—	950
Conradson carbon, percent by weight	0.02	0.11	—	—	0.1	0.30	—
Sulfur, percent by weight	1.55	0.56	—	—	0.79	1.57	1.37

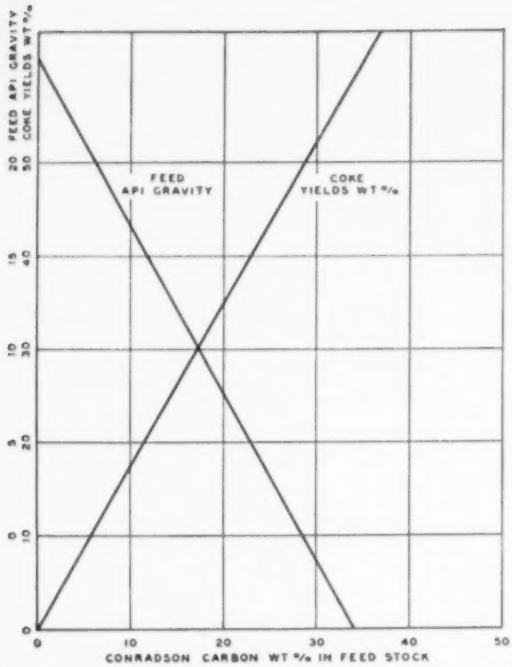


FIG. 3. Approximate relationship between API gravity, conradson carbon of feedstock, and yields of coke in delayed coking of paraffin base stock when producing approximately 950 F end-point gas oil at 25 plus coke-drum pressure.

proximately 920 F, and a recycle ratio based on equivalent fresh feed of approximately 0.25.

For maximum yields of heavy gas oils, the delayed coking unit should operate at lower pressure and lower recycle ratio. The end point of such gas oil usually is governed by the maximum allowable content of metal, nitrogen, and residual carbon.

When processing naphthenic stocks or a mixture containing a high proportion of refractory material having a high metal content such as cracked residue, lighter gas oils would have to be produced to meet the allowable metal content. For light gas-oil production the coking unit has to operate at either a higher pressure, higher temperature, higher recycle ratio, or a combination of the three.

Generally speaking, the lower the pressure and the lower the recycle ratio, the higher the yields and the heavier the gas oil produced.

Yields

Yields of products vary with the source of charging stock, end point of gas oil desired, recycle ratio, and operating conditions.

Yields of coke are in direct proportion to the Conradson carbon in the feedstock and are approximately 1.75 times the Conradson carbon in the feedstock when processing paraffin stock and producing approximately 950 F end-point gas oil. When processing a refractory or naphthenic stock, the yields of coke for corresponding end point of gas oil are slightly higher.

In cases where both Conradson carbon and the API gravity of the feed are not known or not reliable, the relationship between the Conradson carbon in the feedstock and its API gravity can be obtained from Fig. 3 for estimating yields of coke. Fig. 3 shows such relationship when processing paraffin base stock in delayed coking and producing approximately 950 F end-point gas oil at an approximate coke pressure of 25 psig.

Coke yields shown in Fig. 3 are applicable when relatively clean 950 F end-point gas oil with a Conradson carbon

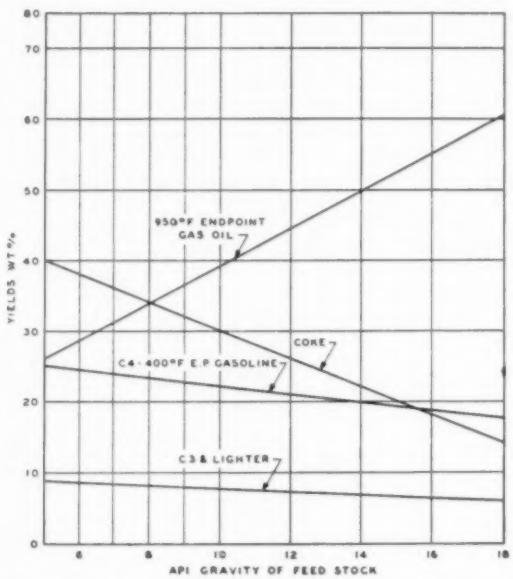


FIG. 4. Approximate yield relationship of delayed coking when charging paraffin base stock and producing approximately 950 F end-point gas oil at 25 psig coke-drum pressure.

TABLE 6 — Pilot Plant Delayed Coking of Non-Petroleum Stocks

	Athabasca[9] Bitumen	Gilsonite[10] (Commercial)	Low-Temperature Coal-Tar Pitch	High-Temperature Coal-Tar Pitch
Charge to unit:				
Gravity, deg API	7.3	—	(1.19)	(1.28)
Conradson carbon, percent by weight	17.9	26.0	31.6	47.9
Sulfur, percent by weight	5.3	0.3	1.62	0.75
Softening point, deg F	—	275 to 500	146	199
Operating conditions:				
Heater outlet, deg F	—	910	905	944
Coke-drum pressure, psig	51	30	40	40
Yields, percent by weight:				
C_3 and lighter	6.2	—	9.4	3.8
C_4—400 F end-point gasoline	17.4	Not Available	—	—
Light gas oil	544	—	—	—
Heavy gas oil	—	—	—	—
C_4+ total distillate	77.8	—	32.1	25.8
Coke	21.0	45.0	58.5	70.4
Product specifications:				
Gasoline end point, deg F	400	—	—	—
Light gas-oil end point, deg F	—	—	—	—
Heavy gas-oil end point, deg F	760+	—	900	900
Gravity, deg API	16.6	—	(1.09)	(1.16)
Conradson carbon, percent by weight	—	—	5.8	3.2
Sulfur, percent by weight	4.0	—	1.35	0.7
Coke:				
Volatile combustible material, percent by weight	10.85	10 to 15	8.5	5.6
Bulk density, lb per cu ft	61	55 to 60	52	55
Sulfur, percent by weight	6.42	0.5	1.1	0.40
Ash, percent by weight	2.95	0.2 to 0.5	1.0	0.06

of not more than 0.3 per cent by weight is produced. This 0.3 percent of Conradson carbon in the gas oil is low enough and quite acceptable as a charge stock for catalytic cracking. If a reported yield of coke from a given operation is lower than shown in Fig. 3, look for an explanation in the examination of the Conradson carbon content and the end point of the gas oil produced. Invariably, it will be found that when the coke yields are reported to be low, the Conradson carbon in the total gas oil is much higher than the 0.3 percent by weight. Irrespective of the coking process, the ultimate gross yields of coke would be approximately the same for a given end point and Conradson carbon of the gas oil produced.

Fig. 4 shows the approximate yield relationship for the four main products when charging paraffin base stock and producing approximately 950 F end-point gas oil at 25 psig coke-drum pressure. For naphthenic stocks the yields of gas and coke are higher with a corresponding decrease in gasoline and gas-oil yields.

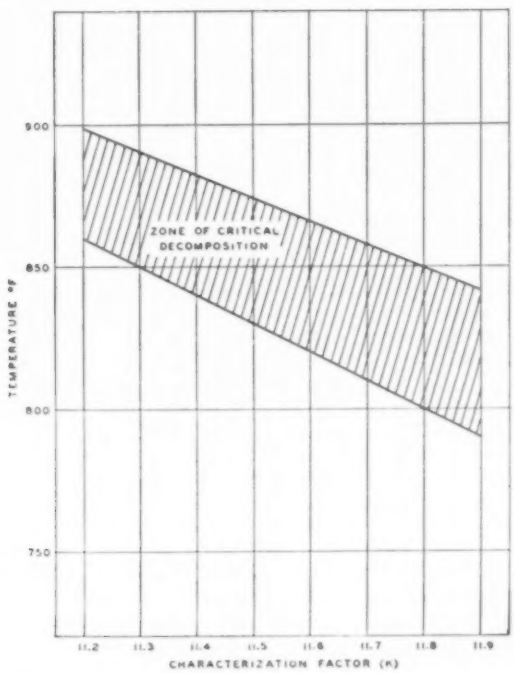


FIG. 5. Zone of critical decomposition.

Critical Equipment Design

The understanding of process variables and their effect on the operation and the design of the unit determines the performance, onstream time efficiency, and the economics of the coking unit. A properly designed unit should also have built-in flexibility to adjust the operating conditions for variations of feedstock, capacity, and product specification.

A. Heater

The most important piece of equipment in delayed coking is the heater. The prime function of a coking heater is to heat the feedstock very quickly to the required outlet temperature and pressure without premature coke formation in tubes resulting in premature shutdown.

It is well known that in many heaters coke formation takes place not at the end of the coking heater where the temperatures are highest, but at intermediate points in the coil where the temperature is below the outlet temperature.

This coke formation starts in the so-called critical zone of incipient cracking or the critical zone of decomposition. Each stock has its own critical zone of decomposition. If the oil passing through this critical zone is in the liquid state and at relatively low linear velocity, then, under the influence of temperature, the slow-moving oil film on the inside surface of the hot tube tends to polymerize and eventually deposits coke in the intermediate portion of the heater, while the tubes toward the outlet are free from coke deposition.

In order to make sure that the heater will not cause coke formation in the intermediate portion of the heater, it is necessary to provide high turbulent motion in the portion of the coil where the zone of critical decomposition takes place.

This turbulent motion or high velocity through the critical zone can be attained by providing such temperature and pressure relationship in the coil as will produce the required vaporization. In practice, it was found that the vaporization of the oil as it passes through the critical zone should be from 5 mole percent to 20 mole percent, depending on the characterization factor **(K)** of the stock.

Fig 5 shows approximate temperature levels of critical zones of decomposition of residual oils for stocks having various characterization factors. The higher the characterization factor of the stock, the lower the temperature will be at which incipient cracking takes place. Since the temperature range of the critical zone of decomposition will also be lower, this zone occurs farther back in the heater, and coke will deposit there unless sufficient velocity and/or vaporization is provided for in the design of the heater.

For paraffinic stock with characterization factor of 11.8, the temperature zone ranges between approximately 800 F and 850 F, while for stock with characterization factor of 11.3, this zone lies between 850 F and 890 F.

Under average temperature and pressure conditions, some very heavy stocks do not vaporize sufficiently to give the turbulent velocity needed to pass through this critical zone without coke deposit in the tubes. In such cases, a controlled amount of steam can be injected at various strategic points to obtain the required velociy.

The amount of steam to be injected varies with the capacity and type of the stock but, in general, is small and will not exceed 1200 lb per hr of steam per 10,000 bbl per day throughput.

When the principles outlined previously are applied to the design of the heater, it is possible to establish for any given stock the proper tube diameter, length of coil, and number of streams, to give the necessary temperature, pressure, and vaporization gradient through the zone of critical decomposition, so that the heater will assure successful operation of long duration without coke formation.

This theory of critical zone of decomposition is applicable in the design of any coking, viscosity breaking and similar service heater.

For a given capacity, a heater designed with a low-pressure differential will result in an earlier vaporization and would require less steam injection to reach the critical velocity than a heater designed with a higher differential pressure. By going to high enough pressure differentials, the liquid linear velocity can be made sufficiently high so that injection of steam and vaporization may not be required. However, the heater with low-differential pressure and equivalent surface will have fewer passes, less auxiliary piping and instrumentation, lower pumping costs, and lower investment cost.

B. Coke Drums

Another major piece of equipment in delayed coking is the coke drum. Its main function is to provide enough volume for accumulation of coke produced during the

normal cycle of 24 hrs. However, in designing a coke drum, it is necessary not only to provide sufficient volume for coke but also to consider the maximum allowable superficial vapor velocity in the coke drum, the minimum free board, and the foaming characteristics of the charge stocks.

These factors determine the minimum diameter and the height of the coke drum.

High vapor velocity and high foaming characteristics of the charge stocks may cause, at the end of the coking cycle, mechanical carry-over of coke forming material form the drum into the fractionator, and from there into the heater, which will result in a premature coking of the heater and a shutdown.

With growing capacity and coke production per unit, the size of coke drums increased gradually for the last 25 years from 10 ft in diameter to present-day 20 ft in diameter, and the height of the coke drum from 40 ft to over 80 ft.

There is no reason why the jet water pump and the decoking nozzle could not be designed for decoking a larger — say, 24 ft diam — coke drum. In many cases, this would reduce the number of coke drums from four to two, resulting in savings in coke drums as well as expensive switch valves, piping, and all accessory equipment connected with the extra pair of coke drums.

It was reported[11] that, due to sudden changes in temperatures during the switches of coke drums, strains and stresses cause numerous mechanical difficulties at the bottom of coke drums and cones which require extensive maintenance and loss of onstream time efficiency.

The most frequently reported difficulties are:

1. Distortion of bottom manhole-neck flange.
2. Weld cracking between bottom cone and manhole neck.
3. Crack formation around cone nozzle attachments.
4. Deformation and warping of shell.
5. Cracking of internal alloy lining.

Most of these difficulties could be attributed to improper location of nozzles and the method of introducing the effluent from the heater and the cooling water and steam into the cone of the coke drum. On coking units where the effluent from the heater and nozzles for quench water, steam, etc., are introduced through the center of the bottom-cone manhole flange, sudden temperature shock of quenching the coke drum, causing the aforementioned difficulties, is avoided because the relatively cold steam and water do not immediately contact the shell of the cone but, by passing through specially designed inside distributors, are heated up by hot coke to a safe temperature before reaching the side of the shell.

TABLE 7 — Typical Coke-Drum Cycle

Operation	Hours
Filling with coke	24
Switching drums	1/2
Steaming out	2 1/2
Water cooling	3
Draining water	2
Hydraulic decoking	5
Headup and test	7/12
Warmup	7/12
Spare time	1/2
Total cycle	48

Practically all coke drums require the use of chromium alloy material to resist the corrosive action of the sulfur in the residual oils. Many years of experience have shown that 11 to 13 percent of chrome will provide entirely adequate corrosion protection in delayed coking service. Because of the heavy wall thickness of coke drums, the alloy protection is always provided in the form of applied liners or clad materials.

In the selection of both lining method and backer materials, the relative costs of the various possible combinations will vary widely from job to job. The possibility of shop fabrication, rather than field erection, and intangible factors, such as quicker delivery, varying fabricating shop loads, etc., have great influence on the relative costs of these vessels. For proper selection of the possible alternative, a specific economic study should be made in each case.

Operation and Maintenance

A. Length of Run and Onstream Time Efficiency

The length of run in itself is not as important as the overall onstream time efficiency. It would appear that the longer the run, the more profitable is the coking operation. However, many factors determine the length of the run and time efficiency, such as characteristics of the charging stock, caliber and experience of the operating personnel and supervision, overall scheduling of refinery operation, maintenance of the equipment, etc. Depending on the overall operation of the refinery, the length of run of a coking unit may vary from three months to one year, but most of the refiners schedule their length of run on coking units for a six-month duration and find that it is more economical than to have longer runs which may require a more extensive maintenance and longer shutdown periods. The number of turnarounds per year for decoking the heater, equipment maintenance, etc., does not affect the economics as

TABLE 8 — Estimated Profitability of 10,000 Bbl per Stream Day Delayed Coking Unit

Basis: Charging 12.4 deg API 15 Per Cent by Weight of Conradson Carbon Reduced Crude Oil; 330 Stream Days per Year; Gas Plant Recovery 75 Per Cent C_3 and 90 Per Cent C_4

	Barrels per Stream Day	Percent by Volume	Percent by Weight	Dollars per Barrel	Dollars per Stream Day	Dollars per Year
Production:						
Fuel gas (fuel-oil equivalent)	515	5.2	5.2	0.20 per million	628	207,000
Propane LPG	477	4.8	2.5	2.20	1,050	346,000
Butanes	348	3.5	2.1	4.40	1,530	505,000
C_5—400 F end-point gasoline	2,490	24.9	18.7	3.90	9,720	3,210,000
Coker gas oil	5,000	50.0	45.3	3.78	18,900	6,240,000
Coke, tons per day	450	—	26.2	10.00 per ton	4,500	1,485,000
Total			100.0		36,328	11,993,000
Gross product value per barrel of charge, $3.63						
Production Costs:						
Feedstock	10,000	100.0	100.0	2.00	20,000	6,600,000
Operating labor	—	—	—	—	—	180,000
Utilities	—	—	—	—	—	341,000
Maintenance	—	—	—	—	—	190,000
Handling loss	—	—	—	—	—	120,000
General and administrative expense	—	—	—	—	—	119,000
Insurance and local taxes	—	—	—	—	—	95,000
Interest	—	—	—	—	—	119,000
Depreciation	—	—	—	—	—	475,000
Total						8,239,000
Net profit before taxes	—	—	—	—	—	3,754,000
Income taxes at 52 percent	—	—	—	—	—	1,950,000
Net profit after taxes	—	—	—	—	—	1,804,000
Payout period after taxes, including depreciation, years	—	—	—	—	—	2.08
Total production costs per barrel of charge, $2.49						

much as the total number of days that the units stays out of operation per year. Most operating units have an on-stream time efficiency of over 90 percent, with some reporting as high as 97 percent efficiency.

B. Time Cycle

Due to daily switching of the coke drums, which disturbs temporarily the equilibrium in the fractionating system, the operation of a delayed coking unit is very sensitive and may result in serious upsets, unless operators are thoroughly familiar with the technique of switching the coke drum, cooling, steaming out, coke handling, and heating up the empty coke drum — in short, all the steps during the entire cycle period and operation. As a result of many years of experience and accumulated know-how, important improvements in the technique of getting the unit onstream, switching of the coke drums, decoking, etc., were introduced. Table 7 shows a typical cycle schedule required for the different steps in a 48-hr time cycle.

Coke Handling and Decoking Water System

One of the most important developments in delayed coking is the hydraulic decoking system invented and introduced by Shell Oil Company twenty years ago.

Hydraulic decoking replaced the ancient and inefficient cable pulling and backbreaking method of removing the coke from coke drums. It was also limited to small-diameter coke drums. Hydraulic decoking[12,13] today is handling coke drums of 20 ft in diameter and undoubtedly will be capable of handling still larger coke drums.

TABLE 9 — Basis of Profitability Study

Production Costs	Dollars	Dollars per Year
1. Labor:		
Operating: 4 men per shift, at $3.00 per hr	140,000	—
Decoking: 3 men, one shift, at $2.75 per hr	24,000	—
Supervision	16,000	—
		180,000
2. Maintenance at 4 percent of investment	—	190,000
3. General and administrative expenses at 2½ percent of investment	—	119,000
4. Insurance and local taxes at 2 percent of investment	—	95,000
5. Utilities:		
85,000,000 Btu per hr at $0.20 per million Btu	135,000	—
25,000 lb per hr steam at $0.50 per 1,000 lb (24 hr per day)	99,000	—
15,000 lb per hr steam at $0.50 per 1,000 lb (5 hr per day)	12,000	—
12,000 lb per hr steam at $0.50 per 1,000 lb (2 hr per day)	4,000	—
9,000 gpm water at $0.01 per 1,000 gal	43,000	—
600 kwh at $0.01 per kwh	48,000	—
		341,000
6. Handling loss, percent of product value	—	120,000
7. Interest on half of investment at 5 percent	—	119,000
8. Depreciation at 10 percent of investment	—	475,000

Economics of 10,000 Bbl Per Stream Day Delayed Coker

A 10,000 bbl per stream day delayed coker with a 15-percent Conradson carbon charge stock has been chosen as a basis of evaluating the economics, since such a unit would produce approximately 450 tons per day of coke, which is the practical limit for a two-coke-drum unit with drums approximately 20 ft in diameter and 65 ft in height.

The estimated installed cost of such a unit is $4,750,000. This sum includes the complete coker, the gas plant to recover 90 percent of the butanes and produce a debutanized coker gasoline, the decoking system, the coke handling system, and the LPG treating facilities. Offsite facilities are not included. However, utilities costs are charged to the unit.

In Table 8 is found the estimated profitability of such a unit. The bases for this profitability study are given in Table 9. As basis for the study, onstream efficiency of 90.5 percent was chosen, which is conservative for commercial operations. Direct and indirect costs have been based on extensive experience and are considered reliable. The product prices chosen may be regarded as realistic present-day averages. For the particular example given, the price for coker gas oil was set at $0.09 a gal, and for coke at $10 a ton. These prices were then varied to determine their effect on the economics of delayed coking, as will be shown later on.

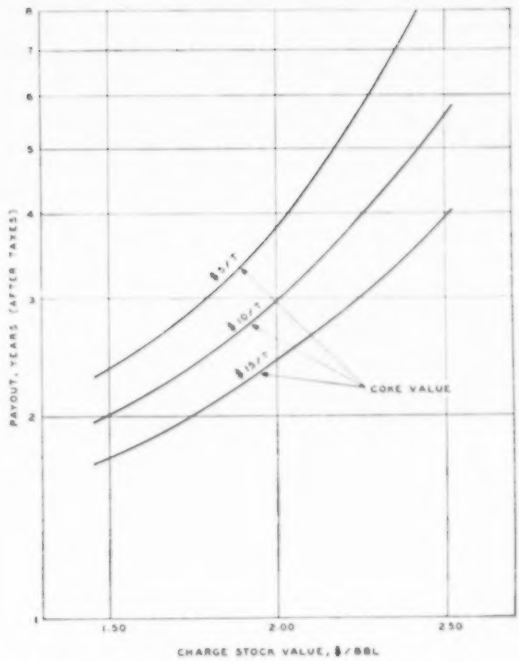


FIG. 6. Payout period — coker gas oil at 7 cents per gal.

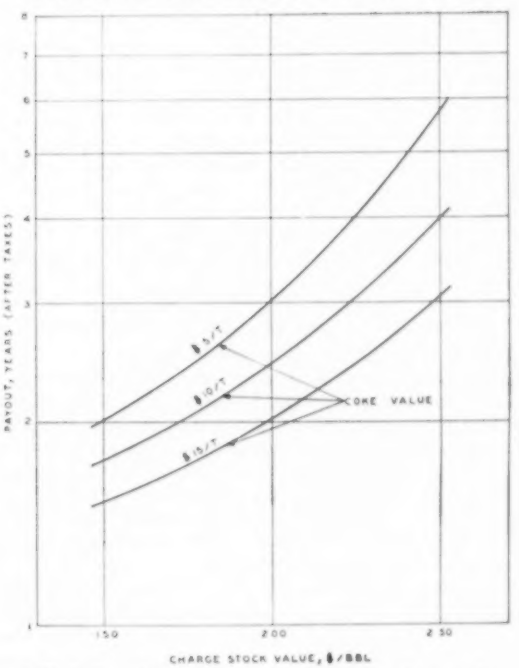


FIG. 7. Payout period — coker gas oil at 8 cents per gal.

It is of interest to look at the relative importance of various factors in the economics of coking. From Table 8, it can be seen that the gross product value amounts to $3.63 per bbl of charge. Of this amount, coke and gas contributed $0.51 or 14.1 percent of the total product value. It can be seen that the most important contributors are gasoline and coker gas oil, which contribute $2.86 or 79 percent of the

total realization. The coker gasoline has been set at $0.50 per bbl under current prices to allow for upgrading to a salable product. Obviously, the values assigned to coker gas oil are prime factors in evaluating delayed cokers.

Curves found in Fig. 6, 7 and 8 relate the value assigned to gas oil, coke, and feedstock value to the payout period which was calculated after federal income taxes but exclusive of working capital requirements and corporate overhead charges. It can be seen that if the feedstock value is $2.00 per bbl or less, the payout period is attractive even for gas-oil prices as low as $0.07 per gallon and coke at $5 per ton.

At feedstock values above $2.20 per bbl, not only is the payout period more sensitive to the value of gas oil but

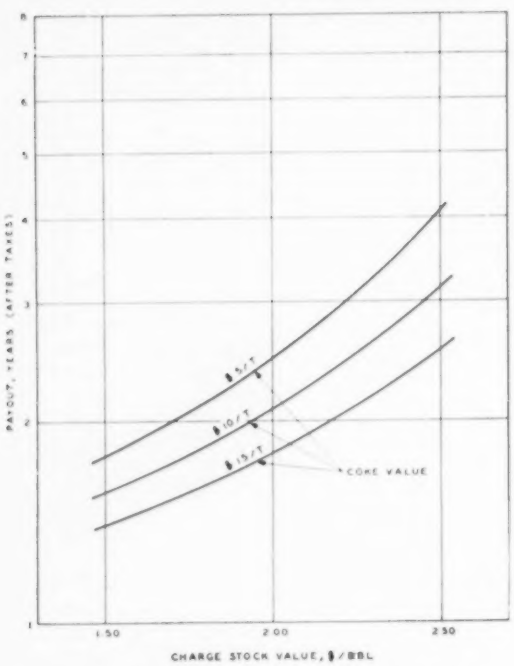


Fig. 8. Payout period — coker gas oil at 9 cents per gal.

the value assigned to coke becomes more significant. Coke prices were assumed at three levels — $5, $10, and $15 per ton. The lower value is representative of a minimum price for coke as a fuel when high in sulfur and containing metal contaminants, which is a function of the feedstock. The higher value is more representative of premium coke when sold for metallurgical and aluminum electrode purposes. The specifications of petroleum cokes for other than fuel purposes are given in Table 10.

The immediate future for the delayed coking process looks bright because of the continuing problem of decreasing demand of residual fuel, the attractive economics of upgrading residual into more valuable lighter products under today's product price structure, and the inherent flexibility of the process to handle different charge stocks producing varying products. The attention paid in recent years to the design of the heater and coke drums has resulted in longer onstream time efficiencies while charging heavier and heavier stocks.

Mr. Valentine Mekler, *Director of Technical Service of The Lummus Company, was born and received his early education in Russia. In 1921 he came to the United States to complete his engineering education. He received a BS degree from the University of Pittsburgh in 1925, and joined the Warner-Quinlan Company as a refinery plant engineer.*

In 1927 he was employed by Universal Oil Products Company at their Riverside research laboratory. During his service with U.O.P. of over eight years, he worked on the development, design and operation of new refinery processes as well as correlating data of a number of pilot and semi-commercial plants.

In 1935 Mr. Mekler joined The Lummus Company as a Process Technologist. During the war he was intimately associated with a number of war projects in charge of process design and coordination of aviation gasoline plants.

He has published several technical papers and has a number of patents issued in his name relating to petroleum refining and processing. He is a member of the American Institute of Chemical Engineers and is a registered Professional Engineer.

Maurice E. Brooks *is the Director of Engineering of The Lummus Company at New York City. He is in charge of the world-wide engineering activities of the company.*

He received a BS degree in chemical engineering from the Cooper Union School of Engineering.

Mr. Brooks joined The Lummus Company as a process engineer in 1940 and has been with them ever since except for a brief military service. Mr. Brooks spent the period from 1950 through 1955 in the Paris office of The Lummus Company, first as Chief Process Engineer, later as Manager of the office. He assumed his present position in 1957.

He is a member of the American Institute of Chemical Engineers.

References

1. "Annual Survey of Capacities of Operating Refineries," *Oil Gas J.* 56 [12] 159-99 (1958).
2. *Petroleum Facts and Figures,* 12th edn., American Petroleum Inst., New York (1956).
3. Anon., "Special Report Refinery Yields," *Petrol. Week* 4 [12] 36-52 (1957).
4. Private Sources.
5. Joseph E. Pogue and Kenneth E. Hill, "Future Growth and Financial Requirements of the World Petroleum Industry," Chase Manhattan Bank publ., Feb. 27 (1956).
6. Frederick G. Coqueron, Harold D. Hammar, and John G. Winger, "Future Growth of the Petroleum Industry," Chase Manhattan Bank publ., Nov. (1958).
7. "Marketing in the Space Age," *Nat. Petrol. News* 51 [2] 114-20 (1959).
8. Private Communications.
9. Anon., "New Raw Material for Coke and Gasoline," *Petrol. Refiner* 35 [8] 153-6 (1956).
10. M. J. Sterba, "Thermal Coking of Oil from Alberta Bituminous Sand," *Proc. Athabasca Oil Sands Conference, Sept. 1951,* Government of Alberta, Canada, 257-70.
11. N. A. Weil and F. S. Rapasky, "Experience with Vessels of Delayed-Coking Units," *Proc. API* 38 [III] 214-25 (1958).
12. "Worthington Hydraulic Decoking System for the Oil Refining Industry," *Bull. WB 1089-B 20D* Worthington Corp., New York (1954).
13. A. L. Foster, "Coker Solves Heavy Fuel Problem," *Petrol. Eng.* 23 [4] C53-C62 (1951).
14. W. L. Nelson, "Properties of Petroleum Coke," *Oil Gas J.* 54 [30] 117-18 (1955).

★ ★ ★

TABLE 10 — Specifications of Petroleum Cokes [14]

	Metallurgical Grade	Aluminum Electrode		Abrasive Manufacture (Maximum)	Carbide Manufacture (Maximum)
		Green (Maximum)	Calcined (Maximum)		
Volatile matter	4.5 to 8.0	12	0.5	9.0	13.0
Sulfur	0.5 or less	1.5 to 2	1 to 2	1.0	1.0
Ash	0.75 or less	0.5 to 1	0.5 to 0.8	1.0	2.0
Calcium	—	0.12	0.12	—	—
Iron	—	0.06	0.5 to 0.8	—	—
Silicon	—	0.06 to 0.08	0.5 to 0.8	—	—
Sodium	—	0.12	0.12	—	—
Combined iron and silicon	—	0.14	0.14	—	—
Combined sodium and calcium	—	0.12 to 0.15	0.15	—	—
Soluble salts	—	0.2 to 0.8	0.8	—	—
Real density	—	—	2.01 to 2.07	—	—
Phosphorus	—	—	—	—	less than 0.1 percent

The Fluid Coking Process – Commercial Experience to Date

James McDonald, *Tidewater Oil Company, Los Angeles, California*
C. O. Rhys, Jr., *Esso Research & Engineering Company, Linden, New Jersey*

THE FIRST COMMERCIAL FLUID COKING unit was put onstream at The Carter Oil Company refinery in Billings, Montana, in December, 1954. Since that time, seven other units have started operations. The operating units vary in size from the original unit of 3800 bbl per stream day fresh feed to the two large Tidewater Oil units of 42,000 bbl per stream day fresh feed each. Information about the commercial units is summarized in Table I.

Most of the commercial fluid coking units have successfully met design expectations and some of them have already demonstrated capacities above the design basis. This is particularly gratifying since the design of even the smaller commercial plants involves scaling up pilot plant results over a hundredfold. **The operations of the commercial units have proven fluid coking to be a rugged, flexible process which can handle a wide variety of feed stocks.**

TABLE I
COMMERCIAL FLUID COKING UNITS

Company	Location	Capacity, B/SD	Date on Stream
The Carter Oil Co.	Billings, Mont.	3,800	Dec. '54
Esso Std. Oil Co.	Baltimore, Md.	10,000	Sept. '55
Canadian Petrofina, Ltd.	Pointe-aux-Trembles	3,800	Aug. '56
Aurora Gasoline Co.	Detroit, Mich.	4,000	Oct. '56
Bankline Oil Co.	Bakersfield, Calif.	4,000	April '57
Tidewater Oil Co.	Associated, Calif.	42,000	June '57
Tidewater Oil Co.	Delaware City, Del.	42,000	Aug. '57
Pontiac Eastern Corp.	Hattiesburg, Miss.	4,800	Dec. '57
TOTAL		114,400	

Startup Problems

In view of the scale-up factors involved in the design of the commercial units from small pilot plant data, it is not surprising that some of the early commercial fluid coker runs were shorter than desired. In the early commercial experience there were both process and mechanical startup problems. Because the mechanical items were typical of any high temperature process, they are not covered in this paper. The principal process startup problems particularly associated with fluid coking were:

1. Coke formation in the reactor overhead system.
2. Maintenance of continuous coke circulation.
3. Scrubber tower fouling.

The current excellent performance of most of the commercial fluid cokers attests the success with which these early operating problems have been solved and overcome. Four commercial plants have demonstrated above-design feed rates. Several have had continuous runs of about 200 days, and two plants have had uninterrupted runs of 300 days.

Condensation

In the early commercial runs some coking of the reactor dilute phase cyclones and cyclone outlets was experienced. Coking of heavy components was preceded by condensation through contact with relatively cool vessel internals or through the temperature drop resulting from endothermic cracking reactions. Once condensation occurs, coking of the liquid proceeds rapidly at the elevated temperatures involved. All of these coking problems were subsequently overcome by minor equipment modifications which either prevented condensation or reduced holding times of the heavy components.

Coke circulation on the fluid coking units has been flexible and controllable. However, process considerations favor minimum outage from the reactor bed to the reactor cyclone inlets. Accordingly, circulation upsets which temporarily reduce or stop the flow of coke away from the reactor to the burner tend to rapidly fill the reactor with coke. Obviously, unless corrective operating steps are taken promptly, the coke will ultimately spill into the scrubber. Appreciation of the need to undertake prompt operating corrective steps whenever circulation falters solved these early coke circulation difficulties without plant revisions.

Scrubber Tower

During the startup of the early commercial plants, the scrubber tower was sometimes difficult to operate because of high solids content in the bottom heavy oil circuits. Accumulation of solids in the scrubber tower bottom circuits frequently followed reactor upsets which temporarily increased the loss of coke particles from the reactor to the scrubber. Equipment additions primarily for handling high solids contents in the bottom circuits, coupled with the smoother present-day performance of the plants, has effectively eliminated these early troubles.

Tidewater Fluid Coking Units

The two Tidewater plants are the largest fluid cokers in operation. Each of these units was designed to process 42,000 bbl per stream day of fresh feed. The size of these plants, their key importance relative to overall refinery operations, and the success with which startup troubles have been overcome provide valuable and interesting insight into the commercial application of fluid coking.

The use of the fluid coking process in Tidewater refineries was first considered early in 1954. A close review of all of the factors showed that fluid coking fitted into the new refinery plan better than the delayed coking process. The refinery was being designed to produce 100 percent of its motor gasoline as 100 Research Octane. The fluid coking process produces less gasoline than the delayed coking process but the gasoline is more easily reformed to higher octane numbers. In addition, there is greater production of catalytic cracking charge stock and less production of gas and coke. This combination allows the refinery to produce the greatest volume of high octane gasoline per barrel of crude charged to the refinery.

Another factor which influenced the choice of the coker was the fact that a single fluid coker could be built to handle a large volume of charge stock. The refinery was designed to charge low gravity, low cost crudes and yet make a large yield of high octane gasoline. This meant that the coker had to be able to handle around 30 percent of the crude

Adapted from a paper presented by the authors during the 5th World Petroleum Congress, New York, June, 1959.

charged to the refinery as low penetration, high carbon residue asphalt. For the 130,000 bbl per stream day Delaware refinery, it was necessary to provide a 42,000 bbl per stream day coker unit.

The unit was essentially completed by December 1956. During initial coke circulation testing, considerable vibration of the large lines was experienced and it was necessary to first make extensive repairs and later change the design of the internal lining and provide more external braces. The first commercial operations were started on June 8, 1957.

The Avon unit operated well from June 8, 1957, to December 14, 1957, an initial run of 189 days. At this time the cold coke circulation stopped and all efforts to re-establish it failed. While attempting to keep the unit on the line, the level in the reactor rose too high and large amounts of coke were thrown up into the scrubber. This caused the loss of slurry circulation and ended the long initial run.

Following the successful start of the Avon unit in June 1957, the Delaware unit went on the line on August 29, 1957. The first run lasted some 300 days or until June 23, 1958. During most of this period, the unit operated well although some difficulty was experienced with the product coke handling system, gas compressors and other auxiliaries. The 300-day run ended due to the loss of the level indication in the reactor. The high reactor bed level, which resulted, caused a large volume of coke to be carried up into the scrubber, similar to the experience at Avon. This caused the loss of the slurry circulation and ended the run.

The Delaware unit was started up on August 9 upon completion of the turnaround. The rate was brought up to some 48,000 bbl per stream day total feed by August 15. At this point the coke circulation was very high (70 tons per min) and the reactor bed level was being held high to minimize vapor phase cracking. The combination of a temperature dip and the effects of a flushing nozzle used in error caused a momentary stoppage of coke flow. This complete stoppage of flow from the reactor caught the operators unaware and again coke was thrown up into the scrubber causing a shutdown. The unit was then cleaned out again and a new run started on September 25, 1958.

Application of Fluid Coking Is Extensive

Successful commercial application of fluid coking has confirmed the ability of the process to handle a wide variety of heavy feed stocks. These commercial results confirm earlier experience with the small scale pilot unit. Some indication of the wide range of possible feed stocks is indicated in Table II which presents typical pilot plant feed stocks and product yields. Notice the feed stock range in this table, from atmospheric residua with initial boiling points as low as 600 to 700 F, to vacuum residua with inital boiling points close to 1200 F. Feeds with gravities as low as −3.5 deg API and Conradson Carbon values as high as 41 percent can be readily handled by fluid coking. As shown in the table, the major product is a gas-oil with a boiling range of 430 to 1015 F, a product well suited for catalytic cracking feed stock.

With any new process, pilot plant data and demonstra-

James McDonald graduated from Yale University in 1937 with a degree of bachelor of engineering in mechanical engineering. Joined Tidewater Oil Company as a junior process engineer in the Bayonne, New Jersey, refinery. Studied chemical engineering at the Polytechnic Institute of Brooklyn. Was advanced to assistant process superintendent at Bayonne in 1947. Starting in 1953, was assigned as a member of the team coordinating the design and erection of Tidewater's ultra-modern Delaware refinery. Following this assignment, he became the assistant manager of the new refinery. Was next promoted to the position of administrative manager of manufacturing responsible for the coordination of all of Tidewater's refinery activities. He is now assistant general manager of Tidewater Oil Company's Western Division, with headquarters in Los Angeles, California.

C. O. Rhys, Jr., assistant director in the Design Engineering Division has been with Esso Research and Engineering Company since 1938. A native of Ohio, Mr. Rhys received a BS degree in mechanical engineering from the Rensselaer Polytechnic Institute, Troy, New York. His early years were spent in process design. In the early 1950's he transferred to Humble Oil and Refining Company for about two years, returning to Esso Research and Engineering Company in 1955.

TABLE II

FLUID COKING YIELDS AND PRODUCT QUALITY

PILOT PLANT DATA

CRUDE SOURCE OF FEED	Los Angeles Basin			Panhandle	West Texas	Coleville	Ordonez	Hawkins	Elk Basin	South Louisiana	
FEED TO FLUID COKER	Vac. Pitch	De-asphalter Pitch	Vis-breaker Tar	Vac. Pitch	Vac. Pitch	Vac. Pitch	Vac. Pitch	Vac. Pitch	Vac. Pitch	Vac. Pitch	Atmospheric Residuum
Fresh Feed											
Gravity, °API	6.7	−0.2	−3.5	17.3	8.4	3.7	2.5	4.2	2.5	11.6	17.7
Conradson Carbon, Wt. %	17	33	41	11	19	21	26	24	30	13	5
Sulfur, wt. %	2.1	2.3	2.1	0.7	3.5	4.2	4.4	4.3	3.8	0.6	0.5
% Distilled @ 1000°F	25	0	5	0	10	20	10	10	0	5	40
YIELDS BASED ON FRESH FEED, WT. % (1)											
C_3 and lighter	8	10	12	7	9	9	10	10	11	8	6
C_4	2	2	2	1	2	2	2	2	2	2	1
C_5/430°F, naphtha	12	12	10	16	16	15	14	14	13	16	14
430/1015°F, gas oil	57	40	28	64	53	50	44	47	40	57	71
Coke (gross)	21	36	48	12	20	24	30	27	34	17	8
Product Quality											
Naphtha (C_5/430°F)											
Gravity, °API	55	54	55	59	56	54	57	56	56	56	56
Sulfur, Wt. %	—	1.7	0.8	0.2	0.7	1.3	0.6	0.9	0.3	0.2	0.1
Research Octane, clear	80	82	—	66	78	82	77	76	77	73	73
Gas oil (430/1015°F)											
Gravity, °API	17	14	15	29	20	15	17	17	17	22	24
Sulfur, Wt. %	1.7	2.2	1.7	0.4	2.6	3.8	3.7	3.4	3.2	0.5	0.4

TABLE III

YIELD TEST RESULTS
BILLINGS FLUID COKER UNIT
CARTER OIL COMPANY

Test No. and Date	Design	1 (3/1/55)		2 (3/2/55)		3 (7/14/55)		4 (3/20/57)		5 (3/21/57)	
Feedstock	Heavy Elk Basin	Heavy Elk Basin		Heavy Elk Basin		Sumatra		Heavy Elk Basin		Heavy Elk Basin	
Type of Operation	Recycle	Once-Through		Recycle		Recycle		Partial Recycle		Once-Through	
Fresh Feed											
Rate, B/D	3,800	3,499		2,475		2,770		3,430		3,450	
Gravity, °API	2.0	—0.2		2.1		7.4		1.7		—5.0	
Conradson Carbon, Wt. %	31.0	30.2		30.4		22.7		32.9		30.6	
Sulfur, Wt. %	3.8	4.21		4.12		—		—		—	
% Distilled @ 1000° F	0	6		4		13		7		5	
Recycle Feed											
Rated, B/D	1,290	0		1,210		937		580		0	
Gravity, °API	8.0	—2.5		—6.3		1.7		—0.5		2.5	
Conradson Carbon, Wt. %	—	25.5		24.4		23.5		24.9		21.7	
Sulfur, Wt. %	4.2	5.12		6.02		—		—		—	
% Distilled @ 1000°F	40	37		32		38		20		19	
YIELDS BASED ON FRESH FEED, Wt. %		Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted
C_3 and lighter	10.3	8.2	9.7	12.3	13.7	14.4	12.3	13.2	11.5	9.5	8.1
C_4	2.0	1.9	2.0	2.8	3.0	4.9	2.7	2.2	2.4	1.6	1.6
C_5/430, naphtha	13.2	11.1	12.4	15.8	17.7	17.1	18.0	10.3	13.6	11.8	10.2
430/1015°F, gas oil	40.5	35.0	30.5	33.2	32.2	40.1	42.3	29.9	29.9	28.0	32.5
1015 + °F bottoms	—	18.2	18.2	—	—	—	—	9.8	9.8	21.0	21.0
Coke (gross)	34.0	25.6	27.2	35.9	33.4	23.5	24.7	34.6	32.8	28.1	26.6
Product Quality											
Naphtha (C_5/430°F nominal)											
Gravity, °API	56	48.8		50.3		—		49.9		45.2	
Sulfur, Wt. %	0.40	0.544		—		—		0.66		—	
Research Octane, clear	75.2	76.8		79.6		—		75.2		—	
Gas Oil											
Gravity, °API	18	20.6		18.5		19.5		19.0		20.2	
Sulfur, Wt. %	3.2	—		3.39		—		—		—	

tions are particularly valuable in establishing correlations for predicting commercial plant performance. Table III presents feed rates, feed inspections, yield data and product quality information for a typical small commercial unit. Yields predicted from pilot plant correlations are shown for comparison and it will be noticed that generally there is excellent agreement between the actual and the predicted plant values.

A formal yield test has recently been concluded on the 42,000 bbl per stream day Tidewater Oil Company's fluid coker at Avon, California. As in the case of the smaller Carter Oil Company unit, the agreement between predicted and actual yields is excellent. The successful application of fluid coking pilot plant data to commercial design is further substantiated by the performance of this large unit at above-design feed rates for sixteen days prior to the formal acceptance test.

Economic Considerations

The success of any new process is ultimately judged on its ability to show an attractive return on the required investment. The attractiveness of fluid coking, as in the case of all processes, must be examined for each specific application and is influenced by the usual factors; i.e., the size of the unit, the product price structure, and the like. It is beyond the scope of this paper to analyze and resolve these economic factors, but three typical cases have been summarized in Table IV. The values shown are based on design throughputs and the actual plant yields being realized on the specific fluid cokers chosen for illustrations. The returns, after taxes, of 25 percent for the small, 4000 bbl per stream day, unit and about 50 percent for the larger, 42,000 bbl per stream day, plants prove that fluid coking can be and is an attractive method for reducing residual fuel production.

TABLE IV. Typical Fluid Coking Economics.

Case	Size, B/SD	Return After 55% Taxes %/Year of Battery Limits Investment (Based on Design Throughput)
A	42,000	57
B	4,000	25
C	42,000	45

The successful operation of commercial plants, ranging in size from 3800 to 42,000 bbl per stream day, has established fluid coking as a versatile, rugged and reliable petroleum processing tool. Most of the operating units have already met design commitments and some of them have materially exceeded design throughputs. Run lengths of several of the fluid cokers have been about 200 days of continuous operation. One large unit has achieved a run of 300 days.

Full-scale demonstration of the fluid coking process affords an interesting lesson in the use of small-scale pilot plant data for commercial plant design. In addition to proving the worth of this approach in the application of a new process, the current satisfactory performance of the commercial plants has justified the minor revisions and the improved operations which were adopted to correct early startup troubles of the first units.

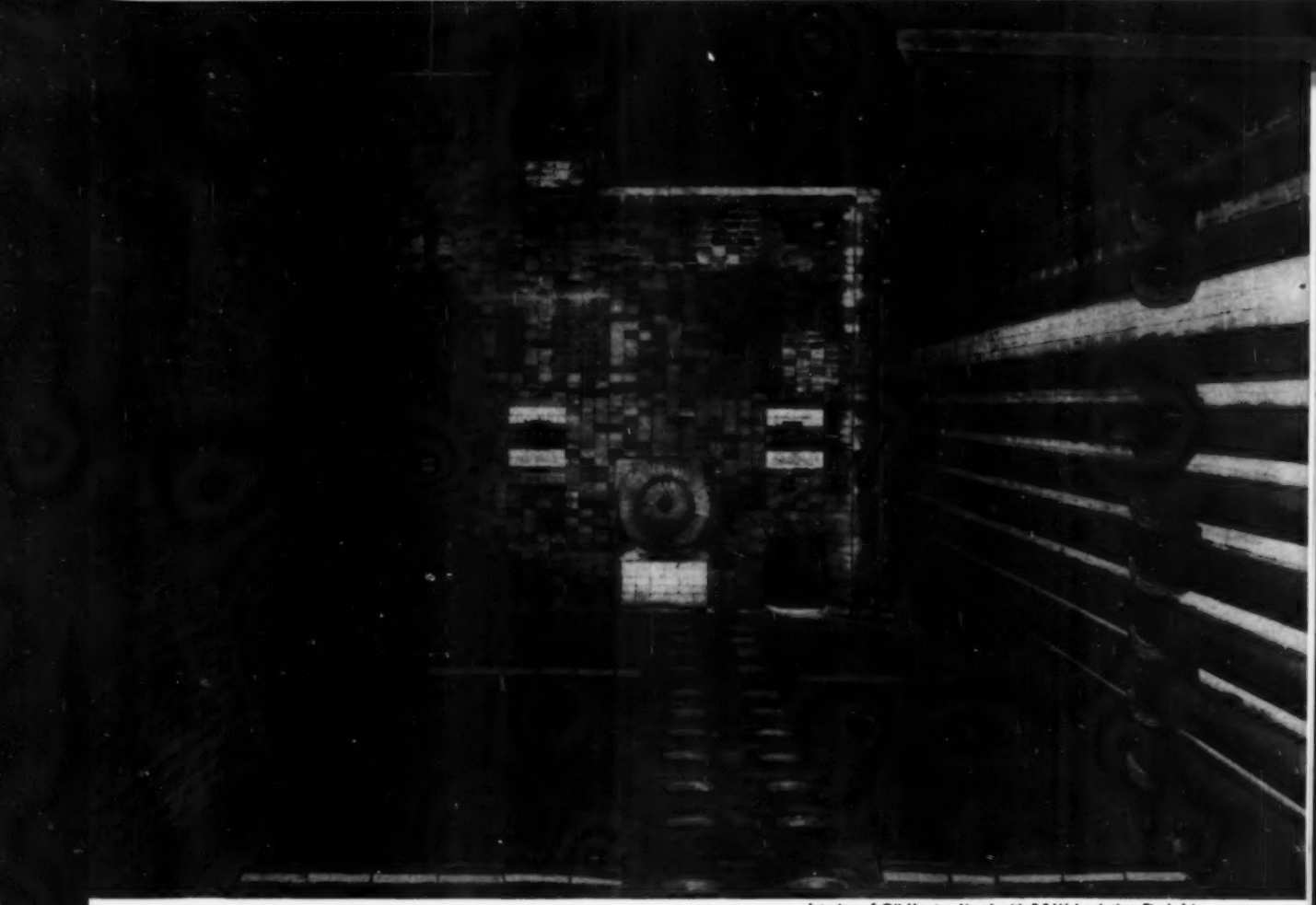
A brief economic review, based on the performance of actual fluid cokers, indicates that the plants are capturing attractive returns on the investment. A typical 4000 bbl per stream day fluid coker shows the lowest return of the three plants reviewed, 25 percent after taxes. Large 42,000 bbl per stream day fluid cokers located on the East and West Coasts of the United States can potentially realize returns after taxes of 57 percent and 45 percent respectively, when operated at capacity.

The commercially proved capabilities of this new process to handle feed stocks ranging from atmospheric to vacuum residua make fluid coking an attractive method for reducing residual fuel production.

References

1. A. Voorhies, Jr. and H. Z. Martin, "Fluid Coking of Residua," American Petroleum Institute, November, 1953, Chicago, Illinois — reviewed in *Petroleum Processing*, December, 1953, pp. 1880-1.
2. F. T. Barr and C. E. Jahnig, "Fluid Coking and Fluid Coke," American Institute of Chemical Engineers, New York Section, October, 1954.
3. A Voorhies, Jr., "The Fluid Coking Process from Pilot Plant to Large-Scale Application," California Natural Gas Assn., April, 1955, Los Angeles, California.

★ ★ ★



Interior of Oil Heater Lined with B&W Insulating Firebrick.

B&W Refractories stay on stream

Long refractory life, low furnace maintenance, and dependable service result from the use of B&W Refractories. B&W offers a wide line of *specialized* refractories *engineered* to give you maximum furnace availability and economy.

Naturally, the refractory selected depends on the specific service. B&W Insulating Firebrick, for example, serve a dual role. First, these durable, lightweight IFB are most efficient insulators, and second, they withstand direct exposure to furnace heat. This means . . .

REDUCED CONSTRUCTION COSTS—The lightweight and high insulating value of B&W IFB combine to lower material costs and simplify furnace design. Because they withstand furnace heat, they eliminate the need for dense refractory constructions backed up with insulating materials. This, together with lightweight, means thinner, lighter wall constructions, often providing savings in structural steel and foundation costs.

REDUCED OPERATING COSTS—The high insulating value of B&W IFB means savings in everyday operation. Per inch of thickness, B&W IFB provide more insulation than any other refractory lining. Less heat is lost, casing temperatures are lower, working conditions are improved and efficiency is increased.

Furthermore, since B&W IFB are light in weight, they store and conduct less heat. Heavy refractories retain heat; in the event of forced shutdown, they can cause burn-out of expensive alloy tubes, where used. The low quantity of heat stored by B&W IFB can be quickly dissipated, thus protecting these expensive tubes.

This low heat storage also permits faster heating and cooling. This means quicker access to the furnace in the event of emergency shutdown. Your maintenance crew can get in the furnace sooner and get it back on stream faster.

Consult your B&W Refractories Representative for assistance with your refractories problem or write to The Babcock & Wilcox Company, Refractories Division, 161 East 42nd Street, New York 17, N. Y.

B&W

THE BABCOCK & WILCOX COMPANY

REFRACTORIES DIVISION

R-829

B&W Firebrick, Insulating Firebrick, and Refractory Castables, Plastics, Ramming Mixes, Mortars, and Ceramic Fiber.

Sulfuric Acid Alkylation—Cascade System

Licensed by: The M. W. Kellogg Company

DESCRIPTION: This process is used to produce high-octane isoparaffin component for aviation and motor gasoline, using sulfuric acid as a carrier catalyst to combine light olefinic hydrocarbons with isobutane. Propylenes, butylenes and pentanes can be alkylated, either individually or as mixtures. Octane rating of the alkylate ranges from 88 to 97 CFRR clear or 130 to 162 F4 with 4.6cc TEL, depending on types of feed.

Olefin-bearing liquid feed is cooled to about 35° to 45°F and contacted with an excess of isobutane in the presence of sulfuric acid catalyst. The olefin feed is split into paralled streams and charged to each reaction zone of the Cascade system. Isobutane-rich recycle and refrigerant are introduced into the first reaction zone only, and pass in series through successive zones to provide the necessary excess isobutane. Series flow of isobutane recycle and acid catalyst with parallel flow of olefin feed is a novel design feature of the Kellogg Cascade reactor. In this manner the entire isobutane recycle stream plus the isobutane-rich refrigerant stream is contacted with only a fraction of the olefin feed stream in each reaction compartment. This arrangement creates a high isobutane concentration and a high isobutane-olefin ratio in each stage, thereby establishing optimum conditions for maximum production of high quality alkylate with a minimum quantity of isobutane recycle.

Reaction products, excess isobutane, and inert components of the feed are separated from the acid catalyst in the settling zone and charged to fractionation equipment for separation of isobutane recycle. Normal butane, which does not take part in the reaction, is then fractionated from the alkylate product. Heavy polymers produced are separated from the desirable alkylate in the rerun tower; isobutane recycle is returned to the first reaction zone of the reactor, and normal butane is withdrawn to product storage.

Vapor resulting from the removal of the exothermic heat of reaction is compressed, condensed and the liquid returned to the reactor as refrigerant. This stream is predominantly isobutane; however, its propane content is higher than elsewhere in the process. A portion is therefore diverted to a depropanizer tower for removal of propane from the system.

Sulfuric acid catalyst is recirculated through the reactor to maintain acid concentration and, as contaminants build up, a portion is withdrawn and replaced by fresh acid.

Acidic material entrained in the effluent hydrocarbons is removed by effluent treater.

OPERATING VARIABLES: — The major factors affecting product quality and yield are isobutane concentration, isobutane to olefin ratio, acid to olefin ratio, acid strength, and reaction temperature. Good dispersion of the hydrocarbon phase in the acid phase is extremely important. Product quality, acid consumption, and yield of 338°F end point alkylate are directly proportional to the above operating factors. The higher the isobutane concentration, isobutane to olefin ratio, acid to olefin ratio and acid strength and the lower the reaction temperature, the higher octane rating of the 338°F end point material and the lower the acid consumption and quantity of heavy polymer formed.

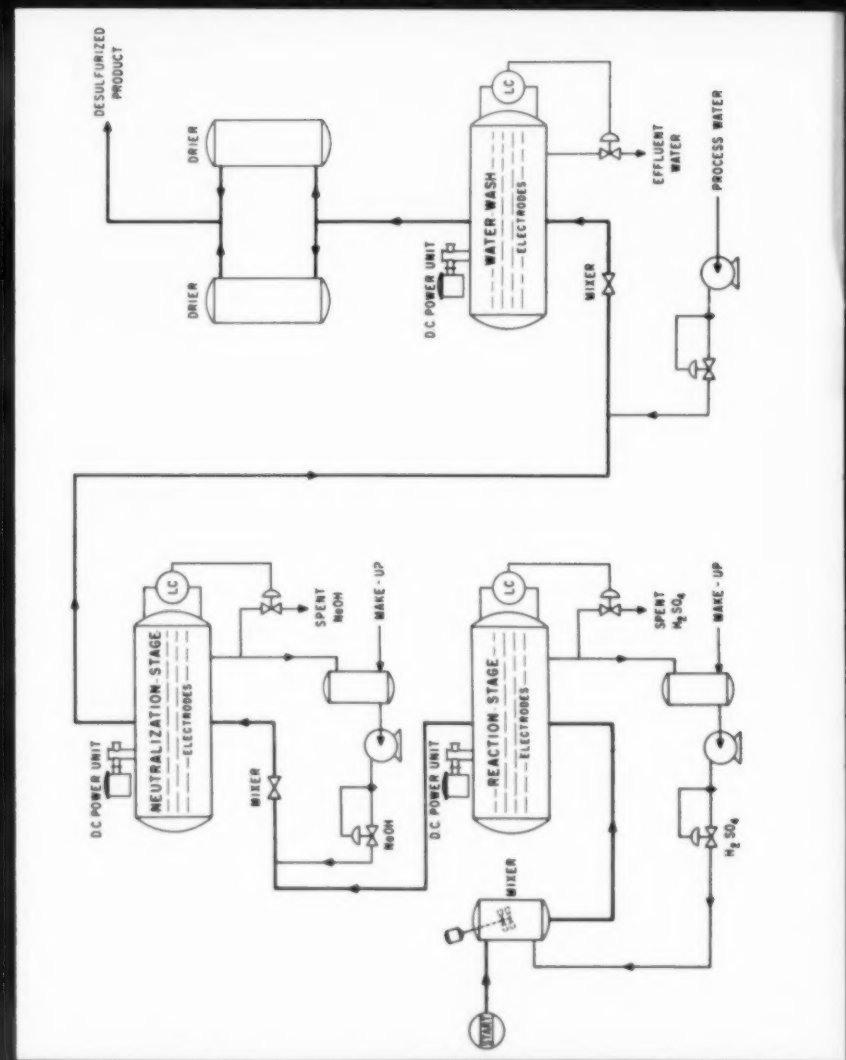
TYPICAL ALKYLATION YIELD DATA

Olefin Feed Type —	Propylene	50% C_3 50% C_4	Butylenes	Pentenes
Yield — Bbl. Alkylate per Bbl. Olefin	1.78	1.74	1.72	1.60
Isobutane Consumption — Bbl. iC_4 per Bbl. Olefin	1.275	1.174	1.106	0.965
Avg. Acid Consumption: Lbs. 98% H_2SO_4 per Gal. Tot. Alkylate	0.6	0.5	0.18	0.4
338°F End Point Alkylate Quality				
F-1 Research Octane No., Clear	92	94.5	97	93
F-1 Research Octane No., 3.0cc TEL	103	108	111	103.6
F-2 ASTM Octane No., Clear	90	92	94.5	92
F-3 or 1-C Performance No., 4.6cc TEL	122	127	134	123
F-4 or 3-C Performance No., 4.6cc TEL	145	150	165	140

(Further data available from the licensor.)

Electrostatic Desulfurization

Licensed by: Howe-Baker Engineers, Inc.



Electrostatic Desulfurization

Licensed by: Howe-Baker Engineers, Inc.

OPERATING CONDITIONS: Operating temperature is normally ambient, and operating pressure is determined by economic design requirements or other elements in the flow circuit.

DESCRIPTION: Electrostatic Desulfurization is a new process for the removal of sulfur compounds from petroleum distillates. The process employs sulfuric acid in combination with a new technique described as "electrostatic mixing" to affect sulfur removal efficiencies in excess of 90 percent. The process is particularly applicable to the pretreatment of reformer feed stocks.

Referring to the flow diagram, it is seen that the untreated hydrocarbons enter the processing system through a small mixer vessel. This vessel is equipped with a turbine-bladed mixer of special design. Sulfuric acid, ranging from 90 percent spent alkylation acid to 98 percent fresh acid, is added directly to the mixer vessel. The acid-hydrocarbon solution is vigorously mixed, reducing the acid particle size to previously determined optimum diameter.

The hydrocarbon containing the acid dispersion then enters the bottom of the first electrical unit, referred to as the reaction stage. In this section, the dispersion is subjected to sufficient electrostatic mixing to insure completion of the oxidation reaction of the sulfur compounds in the hydrocarbon to the disulfide form and subsequently moving the reaction products into the acid phase. In the center portion of the reaction stage, the partially spent acid containing the reacted disulfides is continuously coalesced, collected in the bottom of the vessel, and recirculated until spent.

The hydrocarbon from the reaction stage, containing less than 50 ppm of suspended sulfuric acid is vigorously mixed with sodium hydroxide solution of 5 to 10 percent concentration. This mixture is separated by electrical coalescence in the second, or neutralization stage. Carryover of suspended caustic from this section is normally zero but during periods of major changes in operations it may be as much as 50 ppm of discontinuous phase.

The neutralized hydrocarbon is water washed and electrically coalesced in the third unit. Any trace of suspended water is removed in the mechanical drier that represents the final unit in the processing scheme. The treated product then is sent to the reforming unit.

YIELDS: Loss of hydrocarbon varies with type of feed stock and level of sulfur in the feed. For pretreatment of virgin reformer naphtha, yield losses will usually be less than 0.5 percent.

CHEMICALS: Either 98 percent fresh or spent alkylation sulfuric acid can be used in this process. Minimum spent alkylation acid strength is 88 percent. Acid treats vary from 3 to 10 lb. per bbl. depending on type of feed stock. For pretreating reformer feed stock acid treat will usually be about 4 lb. per bbl. Since caustic is used only to neutralize trace quantities of acid carryover from the reaction stage, strength of caustic is not important. Caustic of 5 to 10 weight percent is most commonly used in the neutralization stage.

UTILITIES:

Power, KWH	3

SERVICE FACTOR: Typical service factor will be better than the associated reformer.

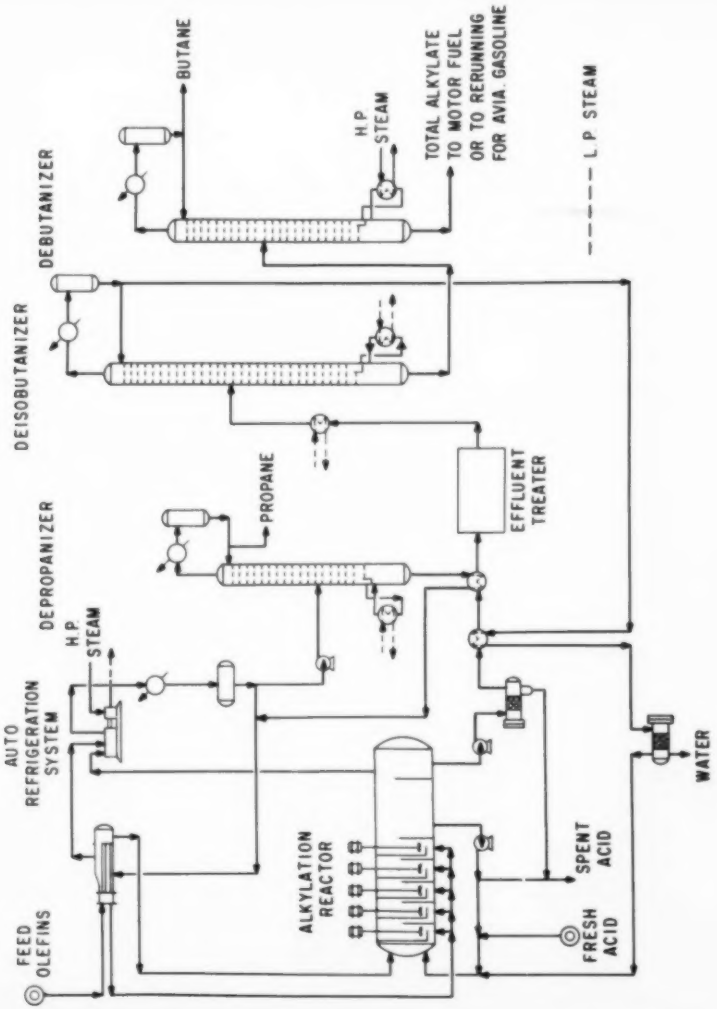
OPERATING PERSONNEL: Fractional manpower is sufficient when the unit is associated with a reformer or any other operating unit. The process is completely automatic and operating variables are reduced to a minimum.

INVESTMENT: Investment costs of a specific unit depend primarily upon the capacity, design pressure, and type of feed stock. Estimates of cost of specific units is furnished to prospective licensees of the process by the licensor.

MAINTENANCE: Labor and material approximately 0 - 1 percent of investment annually.

Sulfuric Acid Alkylation—Cascade System

Licensed by: The M. W. Kellogg Company



A practical approach to . . .

Calculating Tank Heat Losses

Actual field tests and theoretical considerations combine to provide realistic values

W. D. Cowell,
Shell Oil Company,
Martinez, California

THE DETERMINATION of heat losses from large storage tanks by classical heat transfer equations is complicated by a number of factors. Among these factors, which are not easily ascertained and yet are vital to the correct solutions, are:

1. Amount of solar radiation absorbed by the tank during daylight hours.
2. Amount of heat radiated by the tank during night hours.
3. Liquid film coefficient, which is dependent upon convection currents and viscosity at the tank shell surface.
4. Vapor film coefficient of shell and roof, which is dependent on shape and position of surface, fluid properties, and surface temperature.
5. Outside film coefficient, which is dependent on shape and position of surface, atmospheric conditions, and surface temperature.

Tabulations and formulas covering heat losses from large surfaces are available from a number of sources. In all cases, however, the values given are dependent on eliminating or carefully controlling most of the above factors. Thus, they are of limited use in the solution of actual field problems.

Tank heat loss calculations for normal conditions could be reduced to simple equations of the form $Q = U A \triangle t$ where an experimentally determined coefficient, U, would take into account such factors as those noted above.

In order to arrive at realistic values for the overall coefficients, and hence develop a simplified method for determining tank heat losses, a series of tests was run on four storage tanks.

Tank Test Procedure and Conditions

A total of four tanks was involved in the series of tests, with conditions shown below:

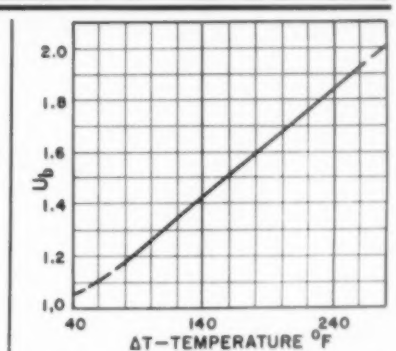
Tank No.	Capacity	Size (Diam. x Ht.)	Duration of Test	Notes
A	5,000 bbl	30′ x 40′	May 13–16, 1955	Shell insulated
A	5,000 bbl	30′ x 40′	Apr. 25–May 3, 1956	Shell and roof insulated
B	55,000 bbl	114½′ x 30′	Oct. 17–24, 1955	Shell and roof insulated
C	55,000 bbl	114½′ x 30′	Oct. 19–24, 1955	Shell and roof bare
C	55,000 bbl	114½′ x 30′	Aug. 30–Oct. 5, 1956	Shell insulated
D	12,000 bbl	45′ x 42′	Oct. 26–28, 1955	Shell insulated

All tanks were charged with hot oil and allowed to stand idle. Fluid properties of the stored liquid were determined and at least once each day the following data were recorded: (1)

T_o = Oil temp F
T_a = Avg air temp F
T_v = Vapor space temp F
(Approx. values of T_v: bare roofed tank, $T_v = 0.75\ T_o$; insul. roof & shell, $T_v = 0.90\ T_o$)
Q_w = Heat loss, Btu/hr (wetted shell-insulated)
Q_w' = Heat loss, Btu/hr (wetted shell-bare)
Q_v = Heat loss, Btu/hr (vapor area-insulated)
Q_v' = Heat loss, Btu/hr (vapor area-bare)
U_b = Transfer coefficient, Btu/hr – ft² – F (bare surface)
U_l = Transfer coefficient, Btu/hr–ft²–F (insulated surface)

$$U_l = \frac{1}{\frac{t}{c} + \text{S.R.}}$$

t = Insulation thickness, in.
A = Surface area, sq ft
S.R. = Surface resistance (for normal conditions use 0.5 Btu/hr–ft²–F)
c = Insulation conductivity at T_m, Btu/hr – ft² – F/in.



$\triangle T = (T_v - T_a)$ for surfaces in vapor zone
$\triangle T = (T_o - T_a)$ for wetted surfaces

T_m = Mean temp F
Wetted area $T_m = \frac{T_o + T_a}{2}$
Vapor area $T_m = \frac{T_v + T_a}{2}$
Bare shell $Q_w' = U_b A(T_o - T_a)$
$Q_v' = U_b A(T_v - T_a)$
Insulated shell $Q_w = U_l A(T_o - T_a)$
$Q_v = U_l A(T_v - T_a)$
Bare roof $Q_v' = U_b A(T_v - T_a)$
Insulated roof $Q_v = U_l A(T_v - T_a)$

FIG. 1. **Tank heat loss calculations** for average or normal conditions.

Tank gage, (2) fluid temperature, and (3) weather conditions. Ambient temperatures were continuously recorded. Periodically, vapor space temperatures and tank surface temperatures were observed.

Most data were collected from tanks over half full and in many cases at levels that would be considered high gage. In general, it was attempted to let the tanks cool for as long a time as possible in order to average out variances in solar radiation, wind, etc. Where possible, the tanks were maintained at a constant liquid level, but due to operational requirements, it was necessary to make some movements out of the tanks in all but two cases (the two tests on Tank C). Where movements had taken place, an average gage was used for heat transfer calculations. Most movements were small enough to have little effect on the calculated results.

Weather conditions ranged from cloudy to sunny with essentially no rain or excessively hot or cold periods. Actually, conditions for the test periods closely approximated average weather conditions for Martinez, California: Average air temperature 63 F, generally sunny, average wind velocity 6 mph.

surface area, average ambient air temperatures, and tank oil temperature, overall coefficients and heat losses were calculated. Heat loss curves obtained are shown in Fig. 4 and 5. Overall coefficients were determined by using the temperature difference between oil and ambient air because of the difficulty in obtaining representative tank surface temperatures. Tank surface temperatures were found to differ quite widely from one side of the tank to the other depending on (1) direction of the wind, and (2) incidence of direct sun radiation. In one check, tank shell surface temperatures for a bare tank varied as much as 25 F from sunny side to shady side of the tank. Oil

DATE		8/30	8/31	9/1	9/2	9/3	9/4	9/5	9/6	9/7	9/8	9/9	9/10	9/11	9/12	9/13
TIME		11:00 AM	8:00 AM	8:30 AM	8:00 AM	8:00 AM	8:00 AM	8:15 AM	8:30 AM	8:00 AM	8:30 AM	8:30 AM	8:30 AM	8:30 AM	8:00 AM	8:00 AM
OIL TEMP. °F	BTTM.	175	170	167	164	161	158	156	152	150	148	146	144	142	140	138
		177	170	168	165	162	160	157	154	152	150	148	146	144	142	140
		179	170	173	170	167	165	162	160	157	155	153	151	149	147	145
	TOP	175	171	163	165	162	160	157	155	152	150	148	146	144	142	140
	AVG.	176	171.75	169	166	160	160.75	157.75	155.25	152.75	150.75	148.75	146.75	146.75	142.75	140.75
WEATHER		CLOUDY	CLOUDY	SUNNY	SUNNY	SUNNY	PT. CLOUDY	SUNNY	PT. CLOUDY	SUNNY	SUNNY	SUNNY	SUNNY	SUNNY	SUNNY	PT. CLOUDY
TIME - H-HRS		EI HRS	24-1/2	24-1/2	24	23	25-1/4	23-1/4	23-1/2	25-1/2	24	23	24	23-1/2	24	
TEMP OIL-°F		4.25	2.75	3	3	2.25	3	2.5	2.5	2	2	2	2	2	2	
AVG AIR TEMP		60	60	60	65	63	65	63	60	63	68	63	65	64	63	
MEAN OIL TEMP		176	171	167	165	162	160	157	154	152	150	148	146	144	142	
MEAN TEMP DIFF		116	111	107	100	99	95	94	94	89	82	80	81	80	79	
SPECIFIC HEAT		.42	.42	.42	.42	.42	.42	.42	.42	.42	.42	.42	.42	.42	.41	
OIL- Q-MM B/HR		1.53	.85	.825	.945	.76	.75	.81	.805	.588	.83	.66	.68	.645	.62	
OVERALL U B/HR-FT²-°F		.845	.38	.4	.45	.35	.38	.41	.41	.32	.36	.30	.37	.38	.37	

FIG. 2. **Heat loss data** for insulated Tank C, taken from August 30 to October 2, 1956.

DATE		9/13	9/14	9/17	9/18	9/19	9/20	9/21	9/24	9/25	9/26	9/27	9/28	10/1	10/2
TIME		8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM
OIL TEMP. °F	BTTM.	138	136	131	130	128	127	125	122	120	119	118	117	114	113
		140	138	133	132	130	129	127	123	122	120	119	118	114	113
		145	143	138	136	135	133	132	128	127	125	124	123	119	118
	TOP	140	138	133	132	130	129	128	124	123	121	120	118	115	116
	AVG.	140.75	138.75	133.75	132.5	130.75	129.5	128	124.25	123	121.25	120.25	119.25	115.5	114.5
WEATHER		PT. CLOUDY	CLOUDY	SUNNY	RITE RAIN	RITE RAIN	SUNNY	SUNNY	SUNNY	SUNNY	SUNNY	SUNNY	SUNNY	SUNNY	CLOUDY
TIME - H-HRS		24	72	24	24	24	24	72	24	24	24	24	73	24	
TEMP OIL-°F		2	5	1.25	1.75	1.25	1.5	3.75	1.25	1.75	1.0	1.0	3.75	1.0	
AVG. AIR TEMP		63	65	65	65	65	65	70	65	60	62	65	68	65	
MEAN OIL TEMP		140	136	133	132	130	129	126	124	122	121	120	117	116	
MEAN TEMP DIFF		77	71	68	67	65	64	58	59	62	59	55	49	51	
SPECIFIC HEAT		.41	.41	.41	.41	.41	.41	.41	.41	.41	.41	.41	.41	.41	
Q-OIL-MM B/HR		.62	.51	.38	.54	.38	.46	.38	.38	.54	.31	.31	.38	.31	
OVERALL U B HR-FT²-°F		.38	.34	.27	.38	.28	.36	.32	.31	.41	.25	.27	.37	.29	

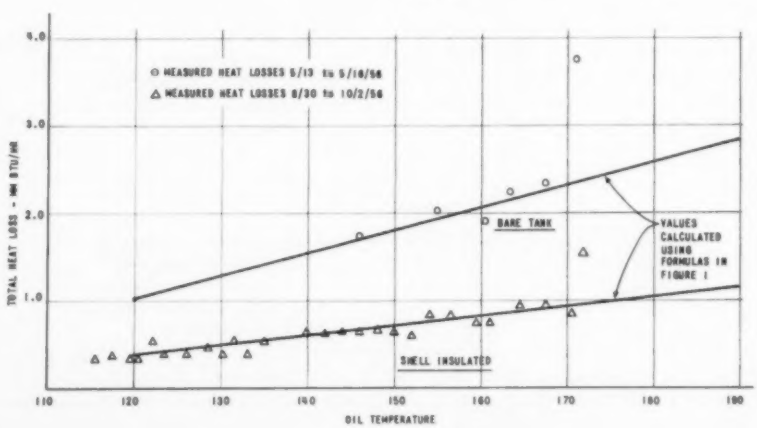
FIG. 3. **Heat loss data** for insulated Tank C (continued from Fig. 2).

FIG. 4. **Measured heat loss** compared to calculated heat loss on insulated Tank C. Tank dimensions: 114½ ft diameter by 30 ft high.

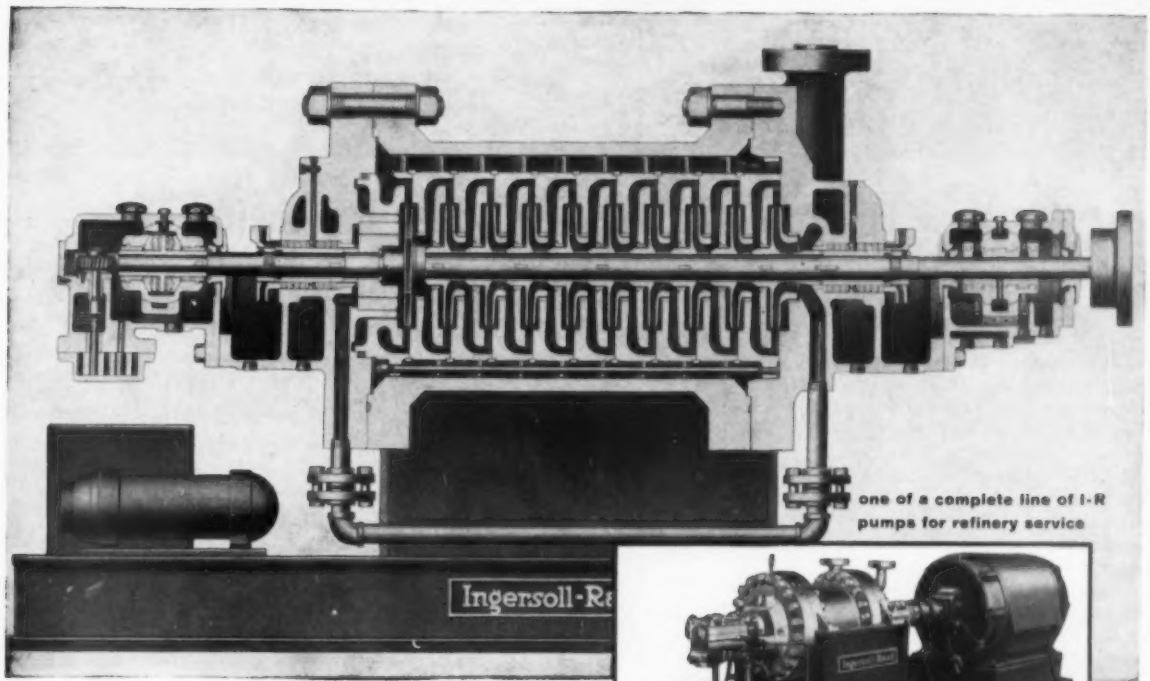
Heat Losses

Heat content of the stored fluid was calculated for each day; differences in daily heat content represented tank heat loss per day. The heat loss values calculated on the basis of day-to-day data fluctuated somewhat (Fig. 2 and 3). This was largely due to the fact that the thermometers could not be read to closer than a full degree. Over a period of days, however, these variations averaged out.

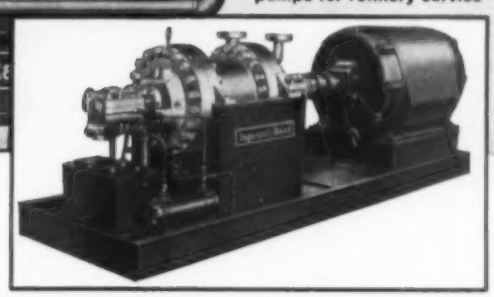
From the observed heat loss, known



NEW INGERSOLL-RAND CHARGE PUMPS
Offer Longer Life on High-Pressure Process Service



one of a complete line of I-R pumps for refinery service



. . . featuring proved "Unit-Type" Rotor Assembly

The new Ingersoll-Rand CMR pump is specifically designed for high-pressure process service, where operation without a spare requires top performance and exceptional dependability. It is a horizontal, multi-stage unit with vertically-split barrel-type casing, suitable for a wide range of low-capacity, high head applications in refineries or other process plants.

Available in 1½ and 2½ inch discharge sizes, the CMR pump will efficiently handle capacities up to 400 gpm, pressures to 1500 psi and temperatures to 750°F.

Some of the outstanding features are noted below. For complete information, contact your Ingersoll-Rand representative.

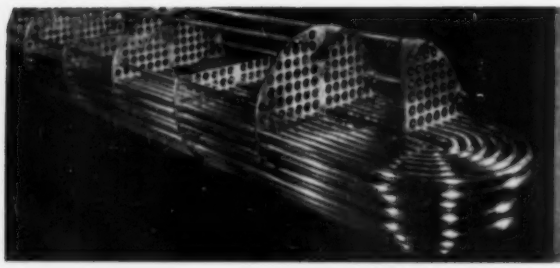
FEATURES:

- **High-Strength Casing** . . . The main barrel is made from centrifugally-cast steel with forged steel ASA flanges welded at both ends. The nozzle head and discharge head are one-piece carbon steel castings which bolt to the casing flanges. The main casing joints are sealed with confined flexitallic gaskets. The pump can be dismantled without disturbing the piping connections.
- **"Unit-Type" Rotor Assembly** consists of separate channel ring segments, impellers and shaft. It can be easily removed from the pump as a unit to facilitate maintenance.
- **Impellers and Wearing Rings** . . . The single-suction, closed type impellers are cast in one piece and mechanically balanced to assure smooth, vibration-free operation. Casing rings, pressed into the channel rings, and locked against rotation, are easily renewed to maintain close running clearances.
- **Hydraulic Balance** . . . Multiple-volute diffusor construction completely eliminates radial thrust. A balancing drum effectively counteracts axial thrust due to pressure differentials across each stage. Residual thrust is taken up by the thrust bearing.
- **Bearings** . . . Spherically seated, self-aligning Kingsbury thrust bearing and sleeve-type radial bearings are pressure lubricated by a gear oil pump driven from the outboard end of the shaft. An oil reservoir and shell and tube-type cooler are mounted on the pump base.

Ingersoll-Rand

10-795 11 Broadway, New York 4, N. Y.

PUMPS • COMPRESSORS • GAS & DIESEL ENGINES • AIR & ELECTRIC TOOLS • TURBO BLOWERS • CONDENSERS



CONDENSER AND HEAT EXCHANGER CLINIC

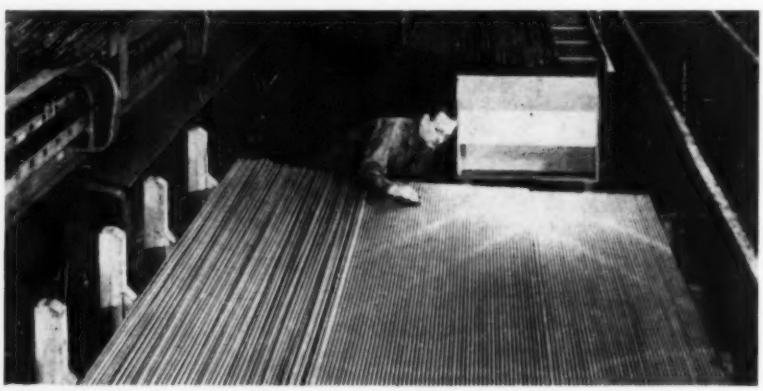
Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, New York

New controls and services meet increasingly critical requirements in heat-transfer units

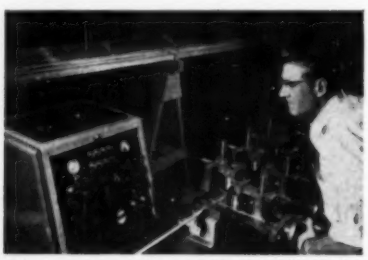
As steam cycles in turbines become more complex—and operating temperatures and pressures rise—the job of the heat-transfer equipment becomes increasingly critical. Nuclear energy plants place tremendous emphasis on continuity of service for even conventional components like condensers. And in many processing plants the cost of shutdowns may range from exorbitant to disastrous.

Assurance that tubes will meet service requirements becomes increasingly important. And The American Brass Company has augmented its normal quality controls with tests and services to help makers of heat transfer equipment prevent possible trouble before it starts.

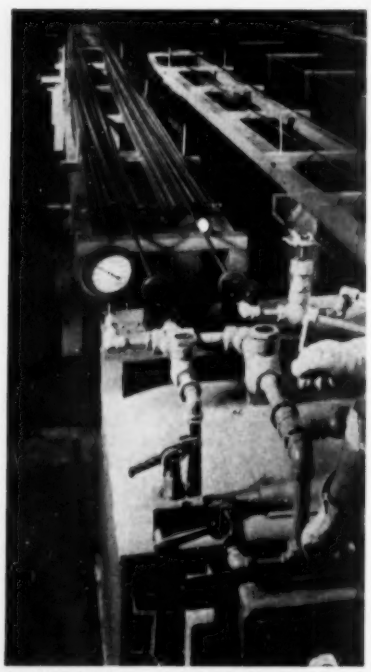
Electronic inspection. All tubes are inspected visually one at a time, both internally and externally. However, where greater assurance is required, the tubes—in straight lengths up to 100'—can be inspected electronically by eddy-current equipment.



All tubes are inspected visually one at a time, both externally and internally.



When required, tubes are inspected by eddy-current equipment, located at the tube straightener.



All U-bend tubes are tested hydrostatically at ASME Code pressures—or higher, if necessary.

Hydrostatic testing. As most U-bend tubes are used in applications involving high temperatures and pressures, all of these tubes are tested hydrostatically—after bending—at ASTM Specification pressures. They can, however, be tested at ASME Code pressures, up to 6000 psi, on request, if the tube size is such that it will withstand the pressure.

Relieving stresses. All U-bend tubes, other than copper, are annealed at the bend area after bending, to eliminate the hazard of stress-corrosion cracking which might occur in service due to stresses that may exist as a result of the bending.

Duplex tubes are widely used in chemical plants and petroleum refineries to meet diverse combinations of corrosive action and/or pressure and temperature. Recently designers have selected them for use in air-removal sections of electric-power-plant condensers where corrosion is very severe.

Broadest service. In helping manufacturers and users of heat-transfer equipment meet day-to-day problems, The American Brass Company has a broad background in the latest developments in heat-transfer equipment's expanding role. And with new mill equipment now in place, it offers the broadest service available in tubes for heat-transfer equipment. For technical assistance in special problems, write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5958 Rev.

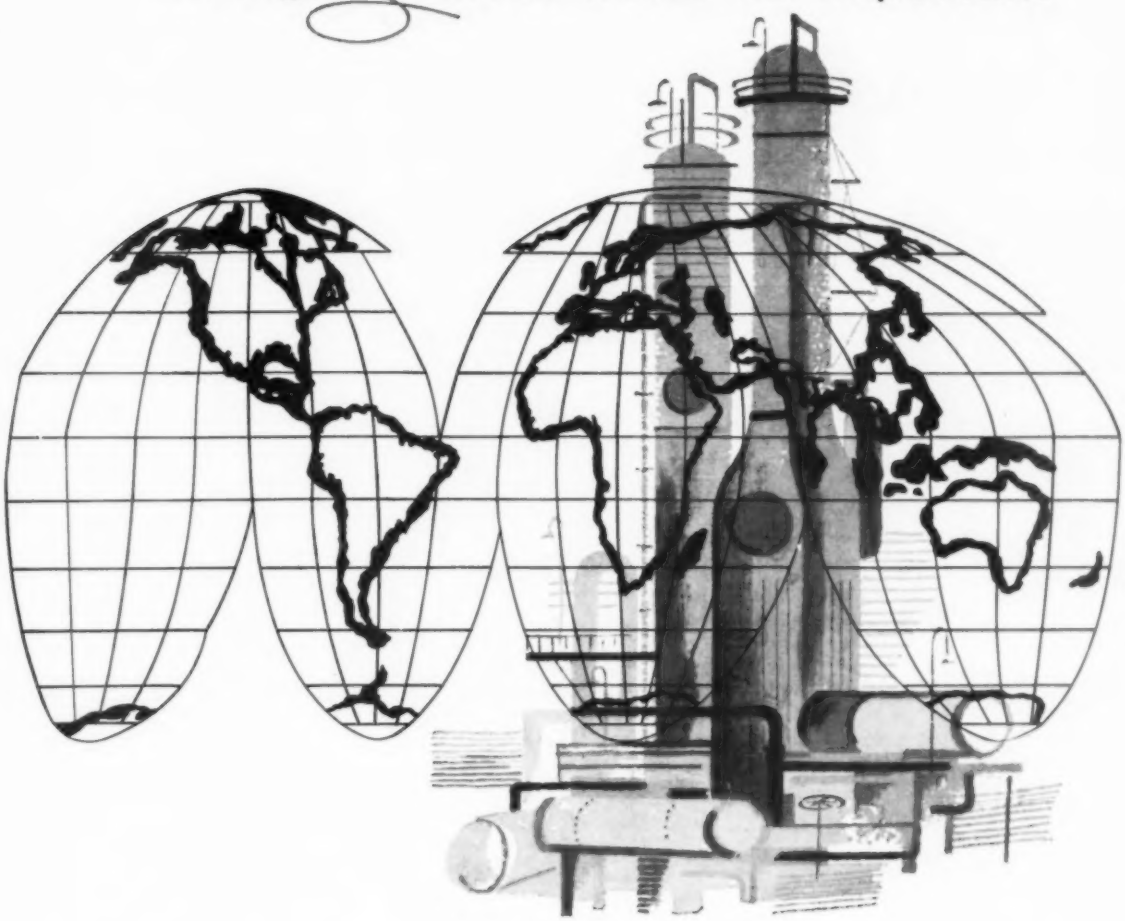
ANACONDA®

TUBES AND PLATES FOR CONDENSERS and HEAT EXCHANGERS

Made by

THE AMERICAN BRASS COMPANY

intangibles were never so important



WORLD-WIDE OPERATION

A timely reminder that plant construction knows no national boundaries is the Fifth World Petroleum Congress. For wherever you plan to build . . . Canada or Cuba, Europe or the Middle East . . . you will find Procon ready and organized to handle your requirements in any part of the Free World. Skilled designers, engineers and construction crews can quickly be on the job building a petroleum, petrochemical or chemical plant or processing unit as required. And you may be sure it will be built to your satisfaction . . . to precise specifications and on time!

PROCON®

PROCON *Incorporated*

1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U.S.A.

PROCON (CANADA) LIMITED, TORONTO 18, ONTARIO, CANADA
PROCON (GREAT BRITAIN) LIMITED, LONDON, W. C. 2, ENGLAND
PROCON INTERNATIONAL S. A., SANTIAGO DE CUBA

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

Check the advantages you enjoy with a personal Subscription to Refining Engineer

☐ YOU GET EACH ISSUE DIRECT — no waiting your turn to read a copy shared with others. Each issue is handy when you need it, where you need it.

☐ YOU CAN CLIP AND FILE ARTICLES — four out of five subscribers do. REFINING ENGINEER is the engineering — operating man's prime reference for up-to-date information.

☐ YOU NEVER MISS AN ISSUE —efficient mailing service keeps issues coming to you promptly when you change your address.

A personal subscription costs less than a penny a day . . .

Mail envelope inserted in this magazine to begin your subscription to REFINING ENGINEER . . . edited expressly for you

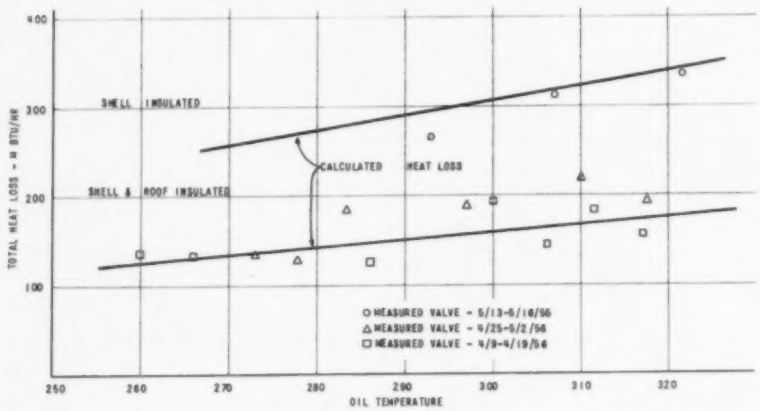


FIG. 5. **Measured heat loss** compared to calculated heat loss of Tank A. Tank dimensions: 30 ft diameter, 40 ft high.

TANK A (30′-0″ diam x 40′-0″ high)

Shell only insulated

Avg tank gage:	25′		Viscosity:	80 SSU at 300 F		
Temp range of the oil:	329 F to 260°F		Avg air temp:	60–65 F		
Gravity:	16.8 API					
Avg heat loss	5/13/55 to 5/14		5/14 to 5/15		5/15 to 5/16	
Total (Btu/hr)	336,000		312,000		267,000	
U (Btu/F-ft²-hr) (Transfer coeff.)	0.287		0.282		0.256	
	4/25/56	4/26 to	4/27 to	4/30 to	5/1 to	5/2 to
After Insulating Roof	to 4/26	4/27	4/30	5/1	5/2	5/3
Total (Btu/hr)	193,000	219,000	188,000	185,000	128,000	134,000
U	.171	.195	.174	.185	.131	.141

TANK C (114′-6″ diam x 30′-0″ high)

Bare tank

Avg tank gage:	28½′			Viscosity:	500 SSU at 155 F			
Temp range of the oil:	172 F to 141 F			Avg air temp:	58 F–65 F			
Gravity:	8.5 API							
	10/19/55		10/20					
	9:10 a.m.-	10/19	8:30 a.m -	10/20	10/21	10/21-	10/22-	
Avg heat loss	2:10 p.m.	2:10p.m.	8:30a.m.	2:35 p.m.	2:35p.m.	8:30a.m.	10/22	10/24
Total (Btu/hr)	3.76MM	2.33MM		2.22MM	1.9MM		2.01MM	1.71MM
U (Btu/F-ft²-hr) (Transfer coeff)	1.74	1.07		1.18	0.94		0.94	0.94

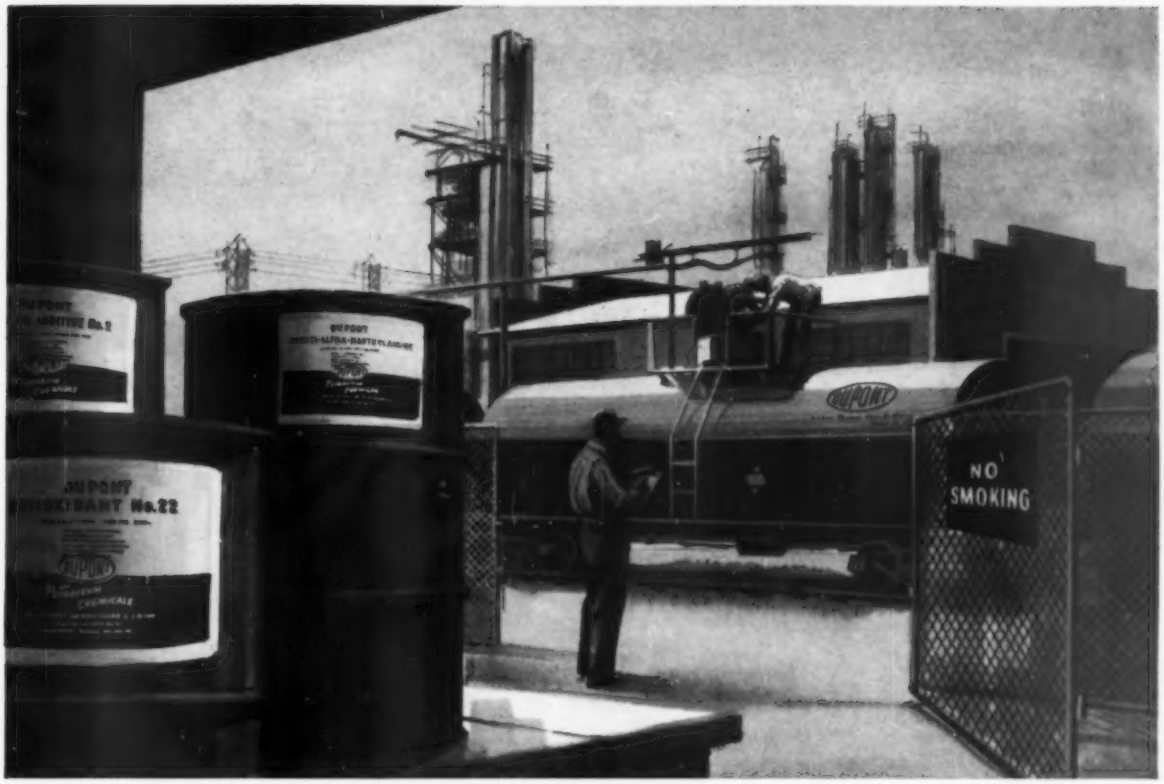
FIG. 6. **Tank Heat Loss Data for Tank A and Tank C.**

temperature was 143 F and the highest shell temperature was 137 F.

Vapor space temperatures were found to be about 75 percent of the Fahrenheit oil temperature in bare roofed tanks with storage temperatures in the range of 120 to 270 F. Vapor space temperatures for completely insulated tanks were about 90 percent of the Fahrenheit temperature of the oil. These factors are consistent enough for use in estimating tank heat losses and have, therefore, been utilized in developing the formulas in Fig. 1.

Although temperatures of the contents of the tanks were quite different, the viscosities were all fairly close. The maximum viscosity was 500 SSU at 155 F for a No. 6 fuel oil tank and the lowest was 80 SSU at 300 F for a road oil tank. Over this range there was no measurable viscosity effect on the heat loss.

From the heat loss relationship tabulated in Fig. 2, 3, and 6, the calculation procedure shown in Fig. 1 was developed utilizing the general heat transfer equation. The procedure for insulated tanks utilizes the manufacturer's published data on insulation conductivities. These formulas should be reasonably accurate for tanks within the following conditions: Bare tank calculation where the oil temperature is between 120 and 190 F. Insulated tanks with an oil temperature between 120 and 350 F. Differing service conditions, such as small movements in and out of the tank would affect these transfer rates, but probably not enough to cause serious error in the use of an average overall coefficient. Weather extremes, such as heavy rain or high winds, would increase heat losses, but values obtained in this particular area are not sufficient to indicate to what degree. ★ ★ ★



A complete line of additives . . . a complete line of services—YOU GET BOTH FROM DU PONT

ADD OCTANE NUMBERS at lowest cost with Du Pont tetraethyl lead. Du Pont refinery technologists can help you adjust operations to get the highest octane rating by the least expensive methods.

IMPROVE FUEL OILS—even heavy residual stocks. Du Pont Fuel Oil Additive No. 2, a stabilizing and dispersing agent, will reduce storage tank sludge and increase operating efficiency at minimum cost.

IDENTIFY GRADES, meet legal requirements, or add a distinctive personality to your gasolines, greases and other petroleum products, with color. Du Pont's wide experience in petroleum dyes and the general field of color can help you get best results.

PREVENT OXIDATION in gasolines with Du Pont antioxidants. Full range available—AO-5, AO-22, AO-29—plus Du Pont technical service to help you get optimum effectiveness at low cost.

STABILIZE GREASE with Du Pont's "Ortholeum" 300 Grease Stabilizer, which offers the combined advantages of a metal deactivator and an antioxidant, keeping grease at top performance for extended periods.

Also:

Du Pont Metal Deactivator, to avoid harmful effects of soluble copper in all distillate fractions.

Du Pont Metal Suppressor, to keep copper out of solution by coating copper or alloy surfaces contacting stock. Supplements Metal Deactivator.

Du Pont Lube Oil Additives for dispersing, and improving quality of crankcase and industrial oils.

Du Pont DMF Antistall Additive for gasolines, to prevent stalling from carburetor icing.

Du Pont RP-2, the three-purpose gasoline additive to prevent rusting, icing and accumulation of deposits in the carburetor throat.

WAREHOUSING SERVICE on additives assures fast and constant supply of all the products mentioned above. Seven warehouses with ample supplies in strategic areas.

RR SIDING SERVICE ON TEL—There are now twenty-three points from which you can get emergency shipments of Du Pont tetraethyl lead. Ample supplies of both motor and aviation mix always ready to roll.

IN-PLANT AND DEALER SERVICES Your Du Pont representative can tell you of the many other services provided, such as market surveys, dealer training aids, safety programs, and process studies.

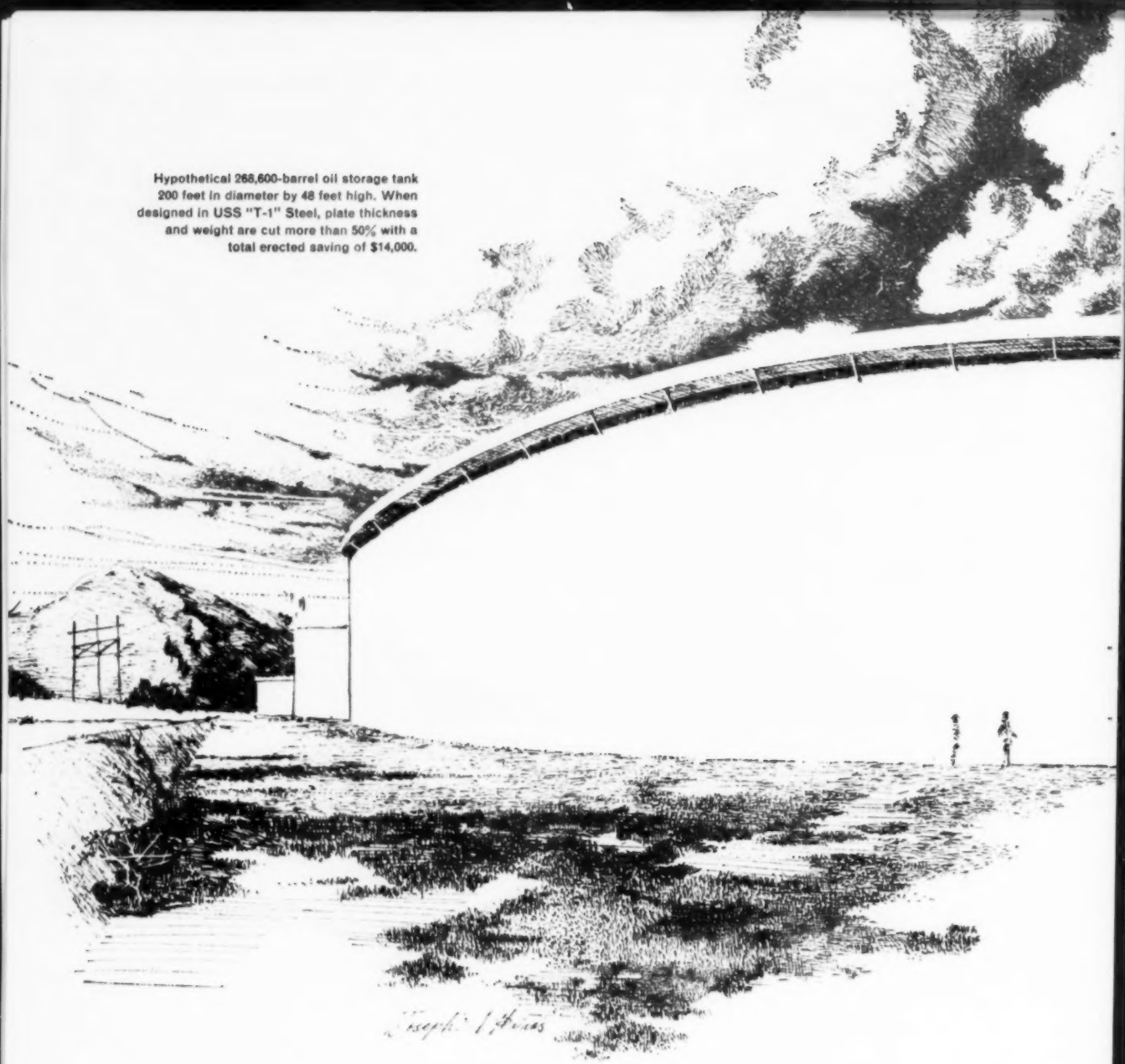
Call your Du Pont representative, or write to the address below for assistance in selecting the right additives for your products. E. I. du Pont de Nemours & Company (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.

DU PONT

Better Things for Better Living
. . . through Chemistry

Tetraethyl Lead
and other
Petroleum Additives

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Hypothetical 268,600-barrel oil storage tank 200 feet in diameter by 48 feet high. When designed in USS "T-1" Steel, plate thickness and weight are cut more than 50% with a total erected saving of $14,000.

Design Advantages of USS "T-1" Steel

The following thickness and cost figures result from comparing *two* designs for the tank—one using ASTM A283 structural carbon steel following API Standards, the other using USS "T-1" Steel at a higher design stress than permitted by API. Note, that although a higher unit stress is used with "T-1" Steel, an even higher safety factor on yield strength is obtained.

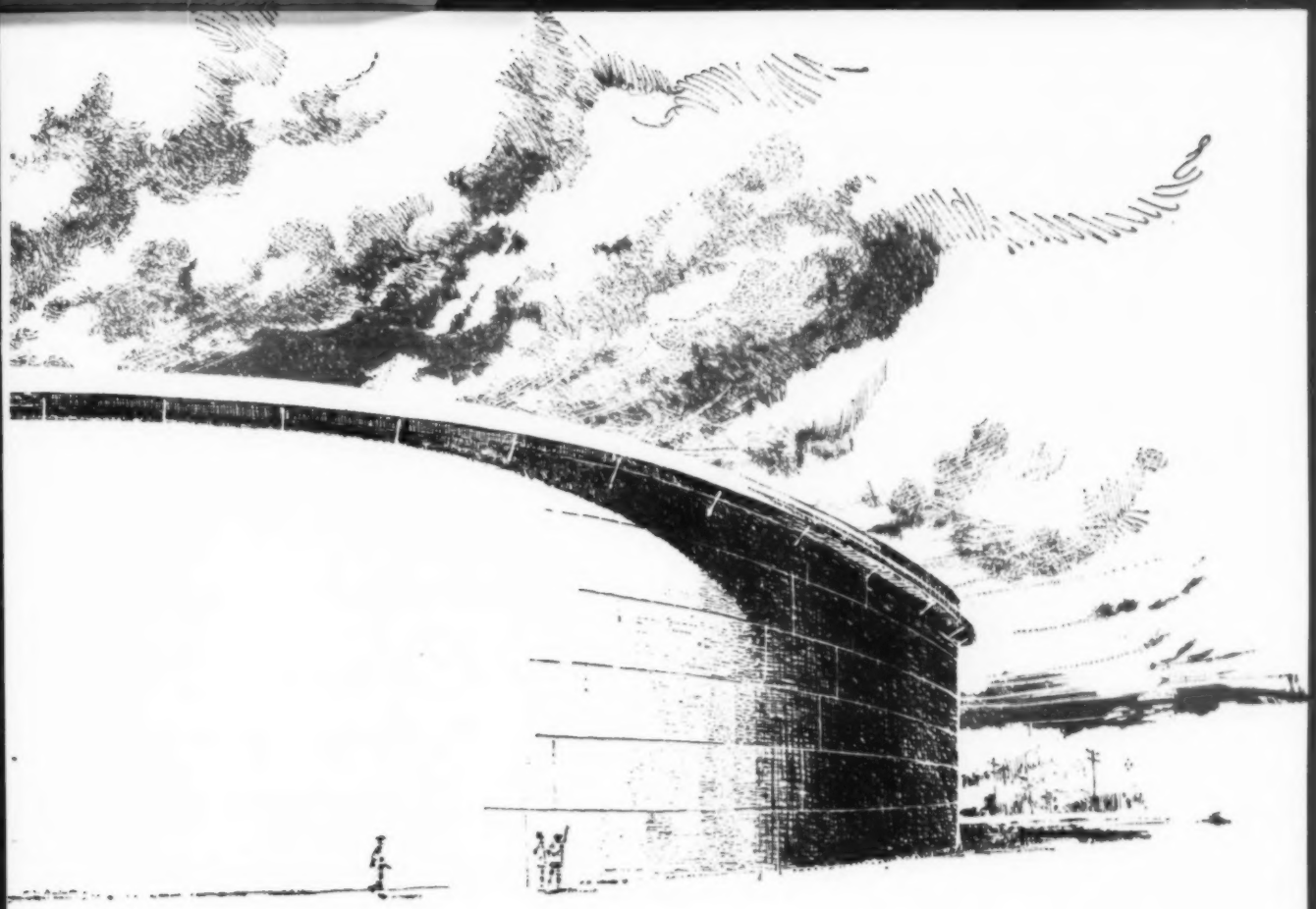
	USS "T-1" STEEL	ASTM A283 Carbon Steel
Yield Strength	100,000 psi	30,000 psi
Design Stress	50,000 psi	21,000 psi
Joint Efficiency	0.85	0.85
Working Stress	42,500 psi	17,850
Factor of Safety on Yield Strength	2.44	1.68

PLATE THICKNESSES COMPARED

	USS "T-1" STEEL	ASTM A283 Carbon Steel
Course No. 1	0.59"	1.37"
Course No. 2	0.49"	1.14"
Course No. 3	0.39"	0.91"
Course No. 4	0.3125"	0.67"
Course No. 5	0.3125"	0.44"
Course No. 6	0.3125" (A283 Steel)	0.3125"

How USS "T-1" Steel can reduce costs (compared with A283 Steel)

Material cost:	$4,400 more
but	
Fabricating cost:	$6,160 *less*
Freight cost:	$4,930 *less*
Erection cost:	$7,310 *less*
Overall savings with "T-1" Steel	$14,000



$14,000 can be saved by building this oil storage tank with USS "T-1" Steel

Here is a design for an oil storage tank that hasn't been built yet. It is 200 feet in diameter by 48 feet high. Capacity: 268,600 barrels.

The tank was designed by a well-known firm in this field —Pittsburgh-Des Moines Steel Co. The costs were estimated for both structural carbon steel to API standards and for building the tank with USS "T-1" Constructional Alloy Steel. In both cases, the bottom plates, roof plates and framing are all ASTM A283 carbon steel. The comparisons apply only to the shells.

USS "T-1" Steel construction costs less. As you can see from the chart, the total cost of the shell construction with USS "T-1" Steel is $14,000 less than with carbon steel, although the cost of the steel itself is $4,400 more. The big savings come from lower costs of fabrication, freight and erection. The reason for this is that USS "T-1" Steel's great strength (100,000 psi minimum yield strength) permits the plate thickness to be reduced more than 50% in most cases. The total steel weight is less, the thinner plates cost less to weld and ship, and fabrication costs are estimated to be lower.

Lower maintenance, too! USS "T-1" Steel has four times the resistance of carbon structural steel to atmospheric corrosion. Research has shown that paint life is extended on steels that have increased resistance to atmospheric corrosion; consequently, longer intervals between paintings is an added advantage of using USS "T-1" Steel.

Retains Toughness down to −50° F. USS "T-1" Steel's exceptional strength and toughness, even at very low temperatures, make it the ideal material not only for tanks, but for pressure vessels, equipment hauling trailers, offshore rigs and other equipment that must be built stronger but lighter. Write for a copy of our booklet, USS "T-1" Steel. United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania. *USS and "T-1" are registered trademarks*

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel

A Haze on the Refinery Horizon

Clouds bearing thunder in the form of politics, economics science and general welfare

L. F. Scheel, *Consultant, San Gabriel, California*

A CHROMATOGRAPHIC analysis of this pessimistic obscurement of the horizon brings reports of aerosols, eye irritants, etc. This alludes, of course, to the recent Air Pollution Control District (APCD) report to the Los Angeles County Board of Supervisors. They propose to limit the olefins content to 12.5 percent or a Bromine number of 20 for all gasoline sold in Los Angeles County. To be more specific, on April 28, 1959, the APCD recommended that this limit be made by law. The average olefinic content for 1957 was 16 percent, for March 1959 it was up to 23 percent with some gasolines going as high as 40 percent. This impending regulation follows on the heels of Rule 62, which abruptly limited the sulfur content to 0.5 percent for all fuel oil burned in Los Angeles County during the months between May 1 and October 31.

Evidence Indicates

Dr. A. J. Haagen-Smit and associates from the California Institute of Technology have presented evidence as early as 1951, that certain unsaturated hydrocarbons participated more vigorously than saturated and aromatic components in the presence of nitrogen oxides to create *SMOG*. For the past two years the Los Angeles County Air Pollution Control District has conducted a thorough study on the effects of olefin content in gasoline and its relationship to the olefin content of the automotive engine exhaust under various modes of Los Angeles driving.[1]

Simultaneously with this investigation, the **Stanford Research Institute,** which is jointly sponsored by the **Air Pollution Foundation** (private industrial interests) and the **American Petroleum Institute,** has conducted a similar engine exhaust study.[2] Their report is summarized as follows: "Under certain conditions, exhausts from all fuel led to appreciable eye irritation and in these cases the olefin-containing fuels led to more reactive exhausts and more eye irritation than the non-olefinic fuels. However, when the mode of operation of the vehicle was adjusted to the AMA driving cycle, no difference in eye irritation was found when comparing results obtained with the basin mix fuel (16 percent olefin, 1957 L. A. Basin average) with those obtained with the aromatic (0.5 percent olefin) or with the paroffinic (0 percent olefin) fuel".[2] The AMA driving cycle refers to the percentage of time at various operating phases. The Los Angeles County APCD uses the following cycle for a comparative weighted average sample: Cruise (average of 20 and 40 mph data) 27 percent; Idle, 5 percent; Acceleration (15 to 30 mph) 26 percent; Deceleration (30 to 15 mph) 42 percent.

The Air Pollution Foundation contends that all of the dynamometer-exhaust **tests are inconclusive** on the basis of the Stanford Research Institute tests. They have demonstrated that gasolines containing no olefins may produce exhaust gases with as much as 40 percent, even as high as 60 percent olefins (by weight) in the hydrocarbons recovered from the engine. Other irritants and offensive compounds such as butadiene and formaldehyde, which are not present in the fuel, yet are similarly found in engine exhaust gases. They contend that the difference between the average olefinic gasoline sold in Los Angeles and one containing no unsaturates are too small to make further reduction in olefinic content of gasolines beneficial.

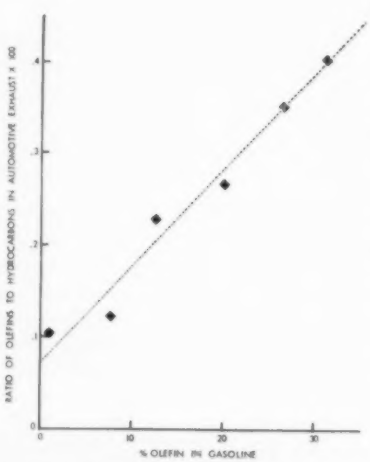


FIG. 1. Effect of olefin content of gasoline on the olefin content of automobile exhaust hydrocarbons. Courtesy of Los Angeles County APCD.

Conclusion Conflict . . . But

It is understandable how different laboratories, pioneering original tests of an elusive nature, under an infinite number of operating conditions and using a interminable variety of fuels, can produce conflicting conclusions. Both schools agree that non-olefinic gasolines produce some olefins and other unsaturates in the engine exhausts. The Foundation maintains the olefinic content in the gasoline has no significant relationship to the quantity of unsaturates emitted from the engine. The APCD hold that the exhaust unsaturates varies in direct proportion to the olefinic content of the gasoline. The conclusion from two outside impartial laboratories tend to support the APCD.

The amount of contaminates polluting the atmosphere of the Los Angeles basin is reputed to produce an appalling several hundred tons per day. There are nearly three million automobiles contributing to this pollution, largely by incomplete combustion of gasoline and partly the result of evaporation from carburetors and from fuel tanks. The last two items can contribute as much as 40 tons per hour at 100 F ambient conditions.

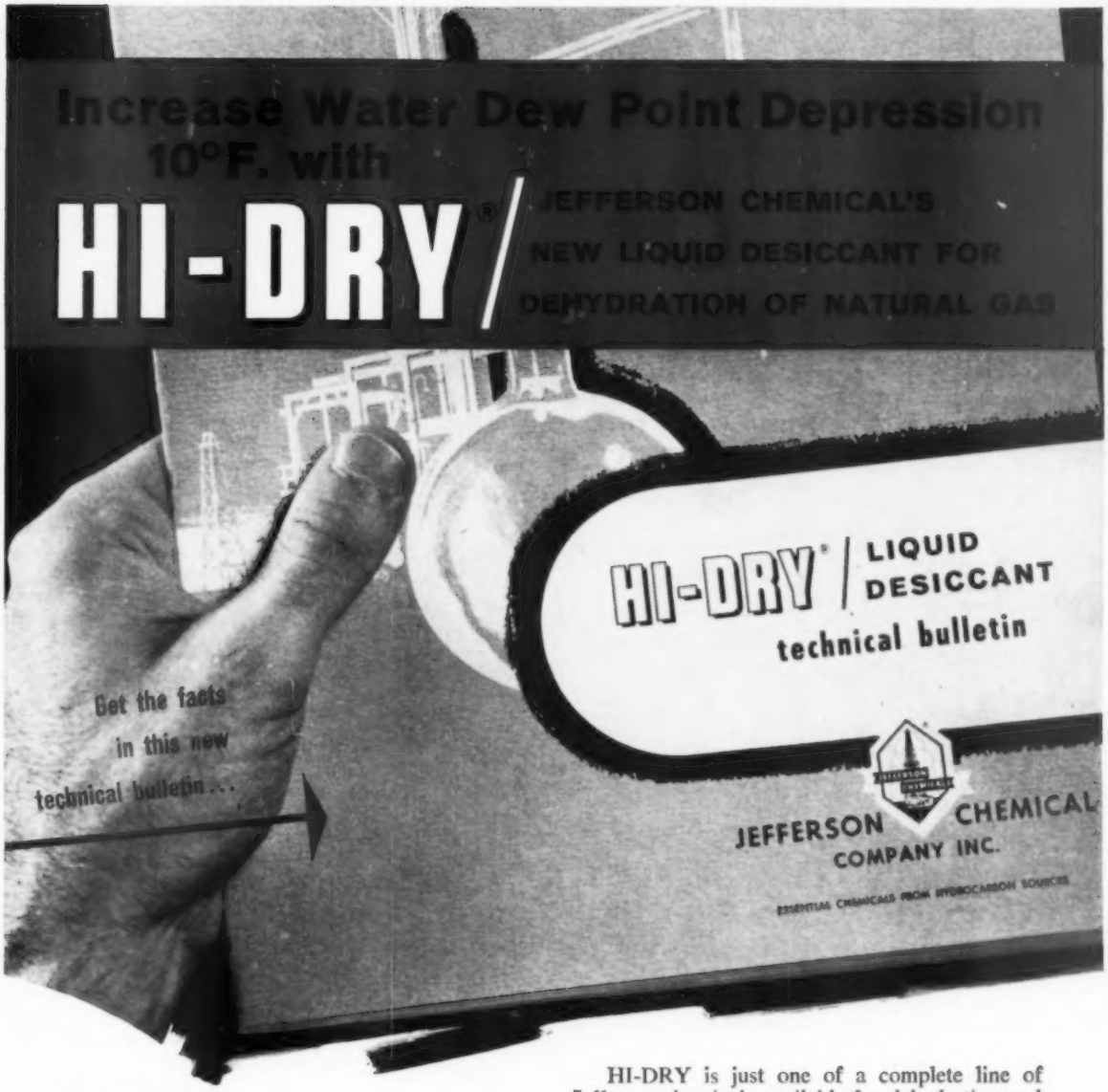
The **automotive engine** not only **functions as a fuel cracking device** to form these offensive unsaturates, but it also creates a still greater tonnage of nitrogen oxides. This is the second ingredient, when in certain proportions to the heavy olefins, photochemically produces the aerosoles and offensive smog.

The Federal Bureau of Mines enters the scene now with an equally comprehensive progress report on extensive series of automotive engine exhaust tests. Fig. 2 and 3 illustrate graphically their results.[3] While the S R I tests were apparently limited to 16 percent olefin gasolines, the APCD used gasolines containing up to 32 percent olefins and the Bureau extended the olefin content to 86 percent. The Bureau did not attempt proportional sampling. Fig. 2 is portrayed on the same weighted average sample as mentioned above.

What Tests Mean

Dr. R. W. Hurns, Director of the Bartlesville laboratory, draws the following conclusions from the Bureau tests[4]:

"a. Non-olefin fuels produce quanti-



HI-DRY® brand liquid desiccant is a tetraethylene glycol concentrate developed specifically to give you the extra dew point depression so often needed in the dehydration of natural gas. Extensive field tests indicate that reconcentration of HI-DRY at 435°F. and triethylene glycol at 375°F. are comparable in level of thermal stability. The lower vapor pressure of HI-DRY, in addition to the increased degree of reconcentration achievable due to its greater thermal stability, offers an advantage in the dehydration of higher temperature gas streams such as those experienced at compressor stations.

Provided in this new HI-DRY technical bulletin are sales specifications, shipping information, typical applications and physical properties. From the physical properties you may readily estimate the results obtainable with various operating conditions.

HI-DRY is just one of a complete line of Jefferson chemicals available for dehydration and sweetening. Jefferson's extensive background of experience in gas treating processes is at your disposal. For helpful technical services, samples of HI-DRY liquid desiccant, or the new HI-DRY technical bulletin . . . contact Jefferson Chemical Company, Inc., 1121 Walker Avenue, P. O. Box 303, Houston 1, Texas.

JEFFERSON CHEMICAL COMPANY, INC.

HOUSTON • NEW YORK • CHICAGO • CLEVELAND
CHARLOTTE • LOS ANGELES

Ethylene and Propylene Oxides, Glycols, Dichlorides • Ethanolamines
Morpholine • Piperazine • Polyethylene Glycols • Nonyl Phenol
SURFONIC® Surface-Active Agents • Ethylene and Propylene Carbonates
Caustic Potash • Caustic Soda • Soda Ash • Sodium Bicarbonate

Essential Chemicals From Hydrocarbon Sources

107

tatively significant amounts of exhaust olefins.

b. From the level produced by non-olefinic fuels, the percent of olefinic material in the emitted hydrocarbons increases generally with an increase of olefin in the fuel.

c. Olefins in the exhaust hydrocarbons increase rapidly with an increase of fuel olefin through the range 0-40 percent, but increase only slightly as fuel is increased further.

d. The fuel effect is roughly comparable for all modes of engine operation.

The foregoing observations are based on a single set of fuels and they should not be considered as definitive for all fuels. More data are needed, particularly from highly olefinic fuels and from fuels with 10 to 30 percent olefin content."

Another significant fact developed by the Bureau was that fuels containing high percentages of alkylate isoparaffins offered little or no improvement over similar olefin content fuels. These results were not conclusive but they were of sufficient significance to bear a mark of caution.

It is reported that the General Motors Research Laboratories support the conclusions of the Bureau of Mines. The United States Department of Health, Education and Welfare, Bureau of Public Health Service have initiated similar investigations in their Cincinnati laboratory.

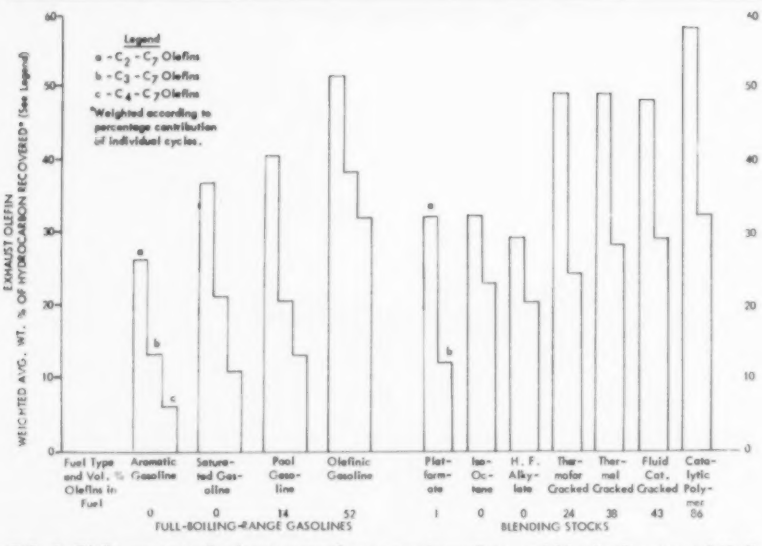


FIG. 2. Olefin content of exhaust gases from several gasolines and blends. Courtesy of U. S. Bureau of Mines and Los Angeles County APCD.

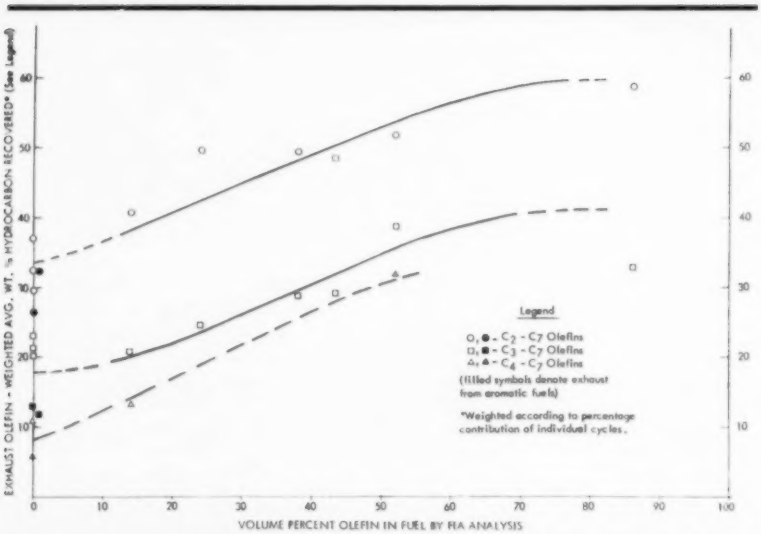

EXHAUST OLEFIN - WEIGHTED AVG. WT. % HYDROCARBON RECOVERED* (See Legend)
VOLUME PERCENT OLEFIN IN FUEL BY FIA ANALYSIS
Legend
○, ● - C_2 - C_7 Olefins
□, ■ - C_3 - C_7 Olefins
△, ▲ - C_4 - C_7 Olefins
(filled symbols denote exhaust from aromatic fuels)
*Weighted according to percentage contribution of individual cycles.

FIG. 3. Olefin content of exhaust hydrocarbons related to fuels. Courtesy of U. S. Bureau of Mines and Los Angeles County APCD.

Where Does the Refiner Stand?

The APCD is conducting a militant campaign to minimize the possibility of an obnoxious smog environ. They have strong public sentiment supporting any course of action. The refiners have a high quality motor fuel as produced. A refinery modification to restrict the olefin content to 12.5 percent for the Los Angeles basin would cost the refiners an estimated $60,000,000 and increase the average motorist gasoline cost by $10 per year. The motorist is getting a bargain at that price in contrast with the likely cost of any other corrective device, such as a catalytic muffler or an afterburner. The APCD appreciates that this measure will not eliminate smog, but they are confident that their Rule 63 will turn the clock back perhaps 10 years as far as smog intensity is concerned. The refiners are going to have their troubles trying to convince the Los Angeles County Supervisors that Rule 63 is taboo because it will not eliminate smog. The battle for the backyard incinerator was waged and lost on the same premise.

Overall Effect

This has been a long and circuitous preface to substantiate a statement that there are factors on the refinery horizon which may upgrade the projected 1960 refinery construction program, in so far as California is concerned. What is true for the Los Angeles basin and California is likely to have similar percussions elsewhere. The San Fernando, San Gabriel and Santa Ana valleys constitute about 0.05 percent of this country's surface. Yet the area contains approximately 5 percent of the automobile population and consumes 3.7 percent of the nation's gasoline production. This makes a gasoline consumption intensity factor of 74 times greater than the national average, per unit of surface. There are other areas that have a greater human population concentration, but none equal the automobile population density of the Los Angeles basin. Those areas that approach the same automobile population density of Los Angeles may anticipate under certain atmospheric conditions, similar smog problems in the near future.

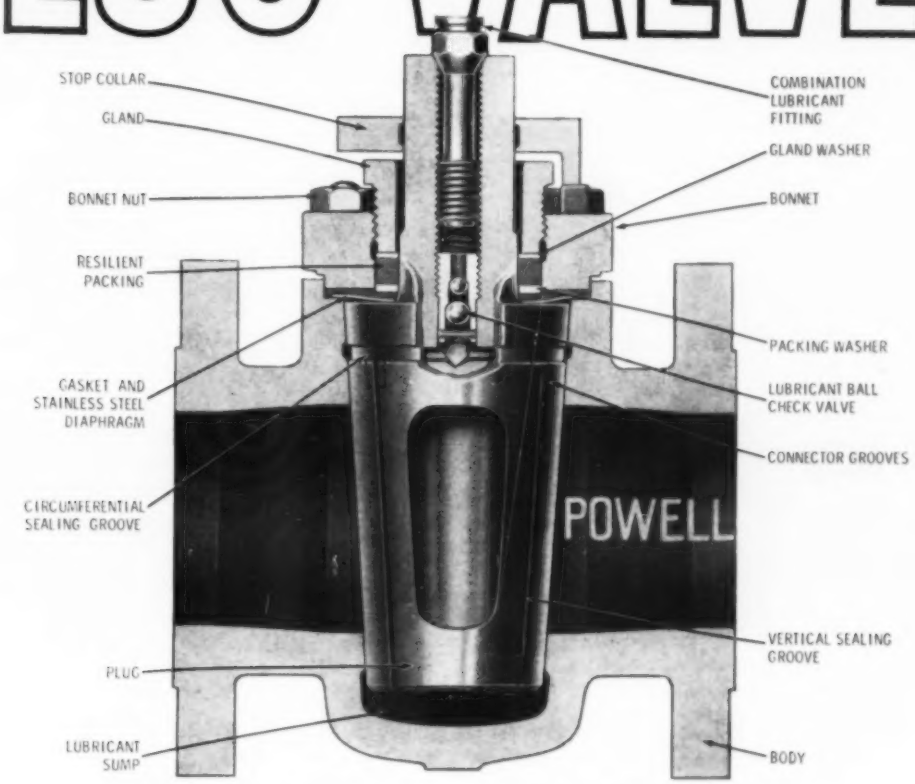
References

1. "Practicability of Smog Control by Reduction in Olefin Content of Gasoline"; L. A. Chambers, APCD of Los Angeles County.
2. Air Pollution Foundation Report, No. 26; Stanford Research Institute.
3. "Cooperative Project on Exhaust Gas Research," 11th Progress Report and 1958 Annual Summary, Bartlesville Experimental Station, F. B. of M. U. S. Department of Interior.
4. "Gas Chromatographic Analyses of Automotive Engine Exhaust"; R. W. Hurn & T. C. Davis. API-COAR, LA 5-12-58.

★ ★ ★

POWELL

LUBRICATED PLUG VALVES



Sectional view Powell Screwed Gland Lubricated Plug Valve.

Like all Powell Valves, Powell Lubricated Plug Valves are superior in their field . . . and have many advantages over other conventional types of Valves.

- Simple design: only three basic parts—Body, Bonnet, Plug.
- Quick, complete shut-off—a quarter turn will close or open the valve.
- Tapered Plug assures positive seating.
- Machined surfaces of plug and body are not exposed in the open position. Any media adhering to the plug when in the closed position is removed when plug is rotated.
- Cavity-free straight passage assures streamlined flow in either direction. Scale and sediment cannot collect.

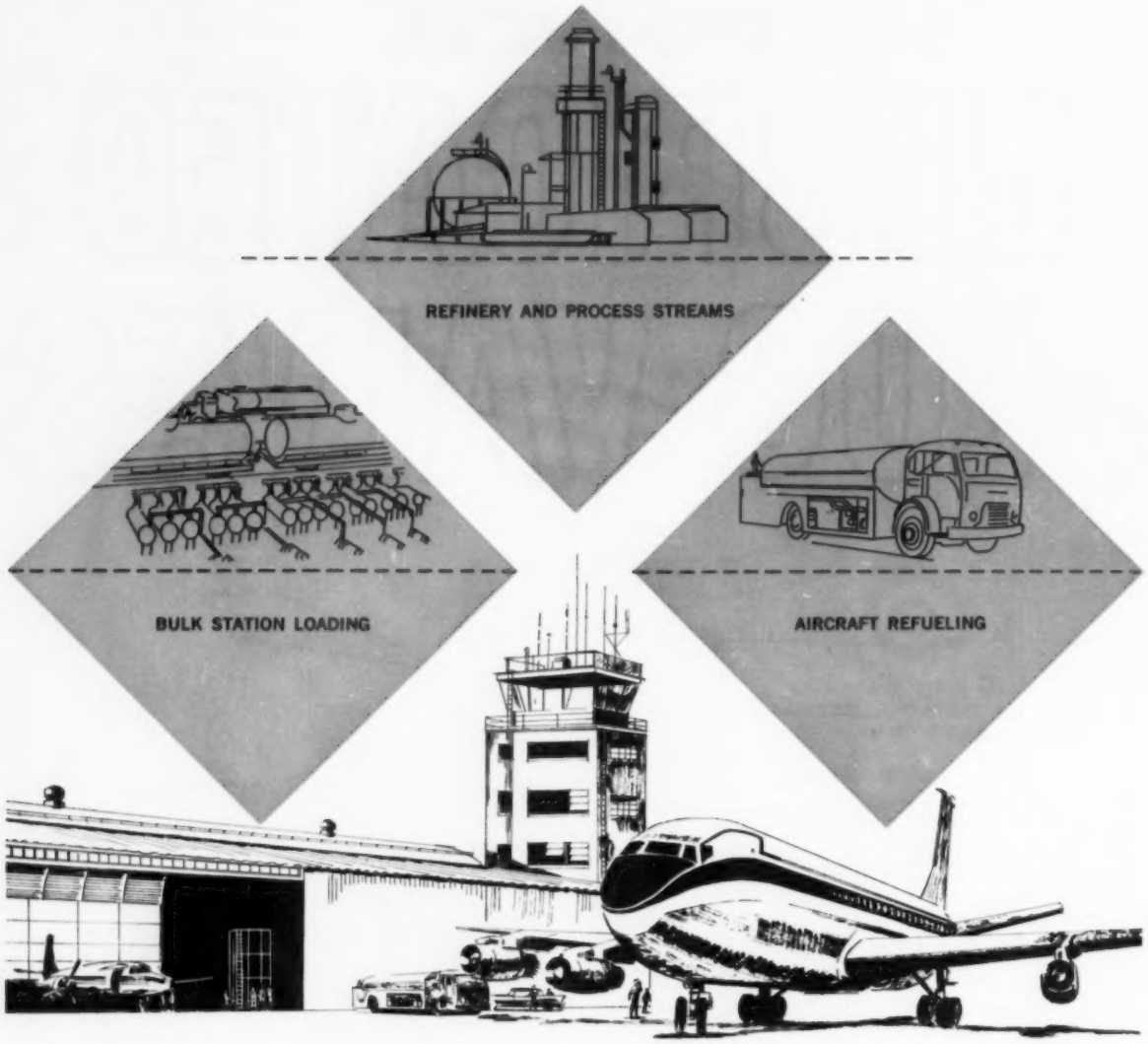
Powell Lubricated Plug Valves are available in sizes ½" through 16", depending on the type required—Semi-steel 175 and 200 pounds WOG;—Carbon Steel ASA 150 and 300 pounds.

Powell can also furnish Lubricated Plug Valves in other alloys on special order.

For all your valve needs, make it a policy to consult your local Powell Distributor—or write directly to us.

THE WM. POWELL COMPANY

Dependable Valves Since 1846 • Cincinnati 22, Ohio



CONVERT EXCELSIOR PACK SEPARATORS

fast, economically with WARNER LEWIS *conversion kits*

This new kit converts your existing excelsior packed separators into high efficiency filter/separators for removal of fine solids and emulsified water in finished petroleum products. In today's exacting requirements in refinery processing, bulk station loading and jet aircraft fueling, it is most important to have clean, dry products. Since Warner Lewis Company is the original manufacturer of excelsior-type separators, our complete files insure correct fit of conversion kit and maximum efficiency of operation at lowest possible cost. Write us today for complete information on your requirements.

WARNER LEWIS COMPANY
BOX 3096 • TULSA, OKLAHOMA

DIVISION OF FRAM CORPORATION

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

PROGRAMMING PLATE TO PLATE . . .

Distillation Calculations

Here is a program available that can be adapted to any medium size computer and amendable to a wide range of distillation problems

Dr. R. N. Maddox • J. H. Erbar
Oklahoma State University
Stillwater, Oklahoma

IN RECENT YEARS, several programs for performing plate-to plate distillation calculations on a digital computer have been described in the literature.[1,2,3,5] Each of these programs was subject to one or more of the following drawbacks:

1. **Restricted to use within a given company.**
2. **Designed for use in a large-scale computer installation.**
3. **Not sufficiently general in nature to handle feed streams with wide variation in relative volatility and enthalpy between the light and the heavy component.**
4. **Required data not generally available to the process engineer.**

The investigation of the behavior of multicomponent systems of hydrocarbons ranging from methane through absorption oil was part of an overall distillation research program at Oklahoma State University. Programs available were not capable of handling streams of this composition. Because of this the plate-to-plate program described in this paper was written. This program has the advantage of being available to the public at large. It is designed so that the general sequence of calculations can be adapted for use on nearly all medium-size computers. In addition to this, the program has proved capable of handling all feed streams thus far attempted. This includes systems with methane through lean oil and other systems containing components ranging from hydrogen through 360 normal boiling point oil.

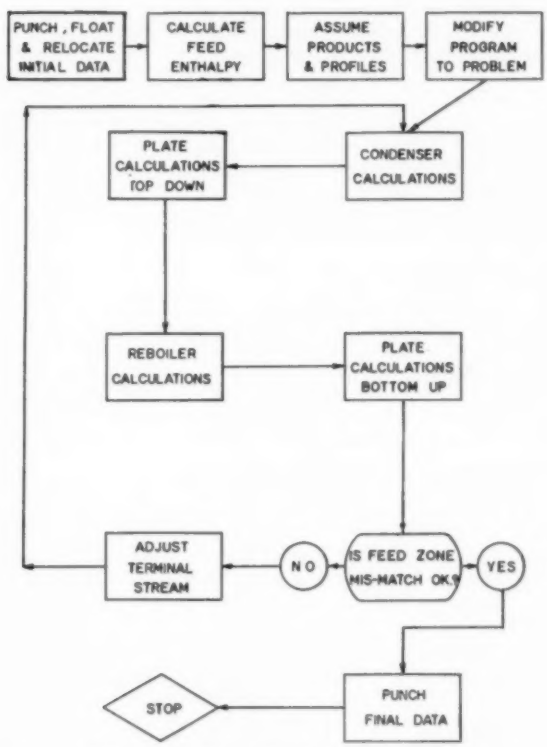


FIG. 1. "Flow Sheet" for calculation sequence.

Adapted from a paper given by the authors at the 38th Annual Meeting of the Natural Gasoline Association of America in Dallas, Texas, April, 1959. Permission of the NGAA to publish this paper is gratefully acknowledged.

The rigorous distillation calculation procedures developed by Lewis and Matheson[4] and by Thiele and Geddes[6] are probably best known to process engineers. The Lewis and Matheson technique was selected for this program because (a) most process engineers are familiar with the calculation, (b) the repetitive nature and simplicity of the calculations makes them adaptable for machine computation, and (c) it is possible to devise a terminal stream composition correction routine that will, through successive iteration, converge upon a correct division of the feed between overhead and bottom streams. Matching of stream compositions at the feed zone does present a problem when using the Lewis and Matheson calculational procedure. As will be shown below, this program embodies a successful solution of this problem.

This program is actually a multiple trial and error calculation involving three variables — product composition, vapor rate profile and temperature profile. The primary variable is product composition, values for vapor rate and tray temperature being dependent on plate composition.

The amount of information required for undertaking a plate-to-plate solution on the computer is essentially the same as the engineer must have before undertaking a solution by hand methods. The data required are:

1. **Tower parameters—number of stages, feed plate location, and operating reflux ratio.**
2. **Feed parameters — composition, rate, and physical condition.**
3. **Enthalpy and equilibrium data.**
4. **Terminal stream quantities and physical condition.**

In addition to the data required, the engineer must decide how much and what kind of output data he desires. Output data for every problem includes:

1. **Input data.**
2. **Feed flash results.**
3. **Summary of results for each iteration.**
4. **Feed plate compositions for last iteration.**
5. **Temperature and vapor profiles.**
6. **Column material and heat balances.**

In addition the engineer may vary the initial data so as to cause the machine to punch:

1. **Complete results for each iteration.**
2. **Vapor and liquid traffics and compositions for each tray.**

The sequence of calculations performed by the computer is shown in schematic form in Fig. 1. These calculations can best be discussed by dividing them into five areas: Preliminary calculations, feed condition and enthalpy calculations, program setup, main program loop, and final calculations.

Preliminary Calculations

All of the engineering data necessary for the solution of the problem is punched out of the machine before any calculations are made. This not only provides the engineer with the means for checking for mistakes but also identifies the specific problem and the conditions under which it was run. During the preliminary calculations all of the data is transformed to floating decimal notation to facilitate machine computation.

Feed Calculations

The various options for feed conditions are part of the input data specified by the engineer. If a feed flash is desired, the flashing range of the feed is determined by bubble point and dewpoint calculations. If the temperature of the feed is within this range of temperatures, the feed is flashed to determine the percentage of vapor and liquid. If the feed temperature is not within the bubble point-dewpoint range, it is treated as either an all liquid or all vapor feed. The feed enthalpy is calculated and punched along with the flash compositions. If the tower being considered is one of a sequence, such that the enthalpy of the feed is known, one of the program options permits flashing of the feed under such conditions as to ensure the proper value for the feed enthalpy.

TABLE I

	GROUP A	GROUP B
1. EQUILIBRIUM CALCULATION	$x_i = \frac{y_i/\alpha_i}{\Sigma y_i/\alpha_i}$	$y_i = \frac{x_i \alpha_i}{\Sigma x_i \alpha_i}$
2. MATERIAL BALANCE	$X_{l_n} = x_i L_n$	$Y_{l_m} = y_i V_m$
	$V_{n+1} = L_n + D$	$L_{m-1} = V_m + B$
3. HEAT BALANCE	$L_n H_L + Q_c + Q_d = V_{n+1} H_V$	$L_{m-1} H_L + Q_r = V_m H_V + Q_b$
4. TEMPERATURE RECALCULATION	$K_{r_n} = \Sigma y_i/\alpha_i$	$K_{r_m} = 1/\Sigma x_i \alpha_i$
	$T_n = A + BK_{r_n} + CK_{r_n}^2$	$T_m = A + BK_{r_m} + CK_{r_m}^2$

TABLE II

COMPONENT	FEED MOLS/HR	DISTILLATE* MOLS/HR	BOTTOMS* MOLS/HR
iC_4	10.89	10.89000	–
nC_4	21.45	20.73580	0.71420
iC_5	25.53	2.63140	22.89860
nC_5	1.70	–	1.70000
C_6	40.43	–	40.43000

OPERATING CONDITIONS

PRESSURE	50.0	REFLUX RATIO	8.3 : 1
NUMBER OF STAGES	45.0	CONDENSER TYPE	TOTAL
FEED PLATE LOC.	23.0	FEED CONDITION	B.P.
D/O	1.05	REFLUX TEMP.	122.8°F

HEAT BALANCES

HEAT IN*		HEAT OUT*	
FEED	15,355.7 BTU/HR.	CONDENSER	32,184.1 BTU/HR.
REBOILER	33,526.3 BTU/HR.	DISTILLATE	3,741.1 BTU/HR.
		BOTTOMS	12,956.8 BTU/HR.

*MACHINE CALCULATED VALUES

Dr. R. N. Maddox

J. H. Erbar

Mr. Maddox is professor and head of the school of Chemical Engineering at Oklahoma State University, and serves as consultant to the Chemical Engineering Division of Argonne National Laboratory, the Oil and Gas Division of Black, Sivalls & Bryson, Inc., and the Cities Service Oil Company. He has also been consultant to the Technical Service Division of Humble Oil & Refining Company. He received his B.S. degree in chemical engineering from the University of Arkansas, his M.S. from the University of Oklahoma, and his Ph.D. from Oklahoma A&M where he was assistant professor. He is a member of the American Institute of Chemical Engineers (chairman central Oklahoma section); Sigma Xi; Registered Professional Engineer (Oklahoma); National Society of Professional Engineers; American Society for Engineering Education; A.I.Ch.E.; Who's Who in Engineering; and Sigma Tau.

Mr. Erbar received his B.S. and M.S. Degrees and is currently working on Ph.D. in Chemical Engineering at Oklahoma State University. His experience includes two years with U. S. Army and short periods in the Natural Gas Department of Magnolia and the Engineering Department of B.S.&B. He is a member of A.I.Ch.E., Sigma Tau and Sigma Xi, and is current recipient of the DX-Sunray Oil Company Fellowship in Chemical Engineering at Oklahoma State University.

Program Setup

In this area the machine tests the input data and modifies the program structure to conform with the particular tower under consideration. Initial estimates of the terminal stream compositions are calculated. If a vapor rate profile is not provided, the machine will assume constant molal overflow for its first trial calculation. If the temperature profile is not specified, the machine will assume a linear temperature profile between the dewpoint of the overhead and the bubble point of the bottoms, based on the initial product assumptions.

Main Program Loop

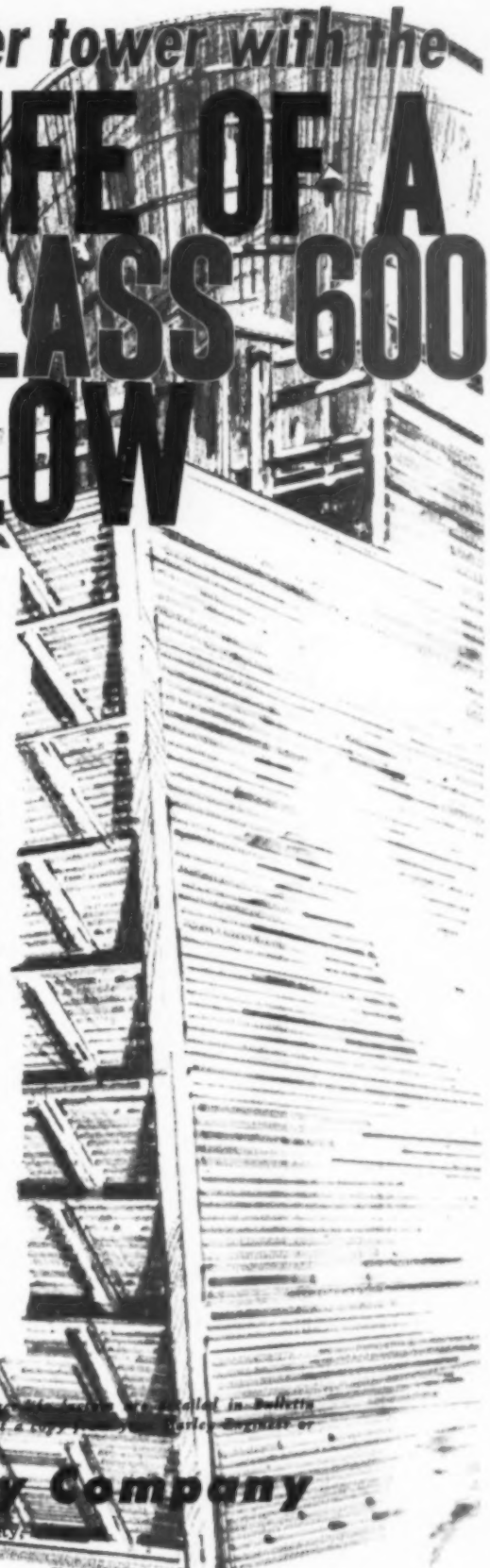
This part of the program makes the calculations for the top down and bottom up plate calculations and the terminal stream adjustment loop. The equations used in the plate calculations are shown in Table 1.

These equations are applied in almost exactly the same manner as would be used in a manual solution. In the top down section, calculations are initiated at the condenser. The sequence of calculations is:

1. The composition, temperature and total quantity of distillate, reflux and top plate vapor are calculated and stored.
2. Heat balances are applied based on the quantities calculated in 1. The condenser heat duty and distillate enthalpy are calculated and stored.
3. The dewpoint of the top plate vapor is calculated (Equations 1a and 4a). This temperature is retained as the top tray temperature in the temperature profile.
4. Material and heat balances (Equations 2a and 3a) are then applied to determine the proper amount and composition of the liquid leaving the plate and the vapor rising from the plate below.
5. At plate count is made to see if the feed plate has been reached. If the feed plate has been reached, the feed plate vapor composition is stored and the computer

You can't buy any other tower with the

SERVICE LIFE OF A MARLEY CLASS 600 DOUBLE-FLOW



Years . . . many more years than those now considered usual service life of cooling towers . . . are engineered into every Marley Class 600 Cross-Flow. Years of full performance; years of low maintenance; years for longer amortization. By incorporating (after comprehensive research) modern inert materials and protective processes throughout Class 600 design, Marley engineers have achieved an over-all durability that prolongs tower life expectancy beyond any current norm.

GLASS FIBER REINFORCED POLYESTER—steel-strong and impervious to corrosion—makes many components invulnerable to corrosion and decay; GRP molded **Fan Blades** are shatter-proof, shock resistant and completely unaffected by moisture or corrosive atmosphere. **GRP Fill Support Grids** position fill bars perfectly and permanently—no nails needed. **GRP Timber Connectors, GRP Retaining Rings** and **GRP Fan Cylinder Positioning** cannot corrode nor are they subject to oxidation that encourages decay in contacted lumber . . . they add vitality to critical areas, as do **Ceramic Timber Ring Connectors** and **Louver Supports** molded of rigid linear polyethylene.

ASBESTOS CEMENT BOARD—fire-safe and wear-proof—forms casing walls and wide, functional louvers that characterize Class 600's.

MARLITH PRESERVATIVE TREATMENT is life-insurance for tower lumber. Applied after fabrication, every piece of wood is deeply and thoroughly impregnated with toxic, proven protection against rot and decay.

MARLEY

The Marley Company

Kansas City

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

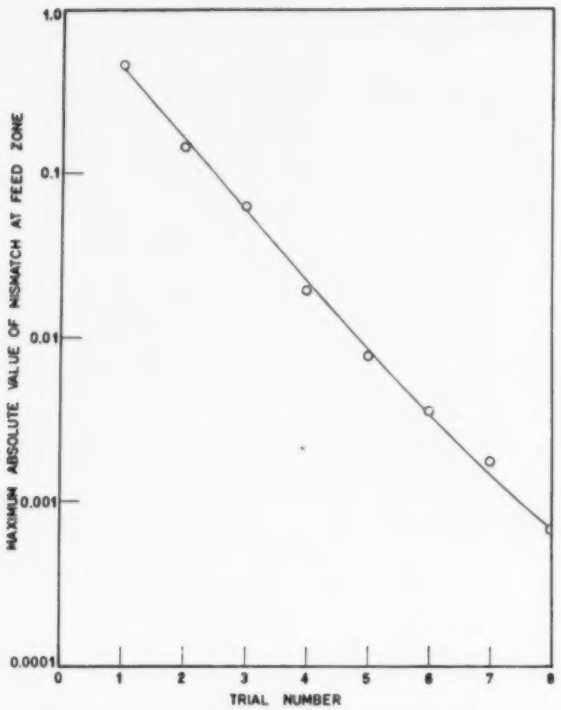


FIG. 2. Convergence curve for Debutanizer Calculations.

proceeds to the bottom up sequence of calculations. If the feed plate has not been reached, the computer goes to the next stage and repeats the calculation sequence.

The sequence of calculations performed for the bottom section is similar to those described for the top section. The equations used are 1b through 4b and this sequence of calculations differs only in detail from that for the top down.

The composition of the vapor entering the rectifying section of the column is calculated in both the top down and bottom up tray calculations. If these values are identical, the assumed distribution of feed components between overhead and bottom products is correct. If the compositions differ by more than the specified allowable error, terminal stream compositions are adjusted and the top down—bottom up calculations repeated.

Adjustment of terminal stream compositions is based on differences in rectifying feed vapor composition for individual components. The ratio of the composition calculated from the top down to that from bottom up is determined. This ratio is used to correct the assumed distribution of the component between overhead and bottom products. The smaller mole quantity is adjusted by multiplying or dividing by the correction factor. The second is then determined by material balance.

The four cases listed below help clarify the manner of terminal stream adjustment.

Case I.

Mole fraction of component resulting from top down calculations is larger than that resulting from bottom up (correction factor < 1.0). More moles of the component in distillate than in bottom. Number of moles of the component in bottoms is multiplied by the correction factor. Number of moles in distillate determined by material balance.

Case II.

Mole fraction of component resulting from top down calculations is larger than that resulting from bottom up. Fewer moles of component in distillate than in bottoms. Number of moles of component in distillate is divided by the correction factor. Number of moles in bottoms determined by material balance.

Case III.

Mole fraction based on bottom up calculations is larger than that based on top down (correction factor > 1.0). More moles of component in distillate than in bottoms. Number of moles of component in bottoms is multiplied by correction factor. Number of moles of component in distillate determined by material balance.

Case IV.

Mole fraction based on bottom up calculations is larger than that based on top down. More moles of component in bottoms than in distillate. Number of moles of component in distillate is divided by correction factor. Number of moles of component in bottoms determined by material balance.

After the terminal stream adjustments have been made, the new total distillate quantity is checked to determine if it is within the specified range. If total distillate is satisfactory, the adjusted terminal stream quantities are used as a basis for another plate-to-plate calculation. If total distillate quantity is outside the specified range, component distributions are adjusted to bring the total quantity to the specified value.

Final Calculation Block

In the final calculation block, the machine punches as output data the information desired by the engineer. In every case, temperature and vapor rate profiles and final material and heat balances are punched.

In this program the problem of non-distributed components is handled very conveniently through the use of so-called floating decimal arithmetic. By carrying component compositions throughout the calculations as some number between 0 and 1 multiplied by the appropriate power of 10, it is possible to handle any number between 10^{50} and 10^{-50}. In nearly all cases, this provides sufficient latitude to avoid the necessity of arbitrarily introducing components on various plates in the column.

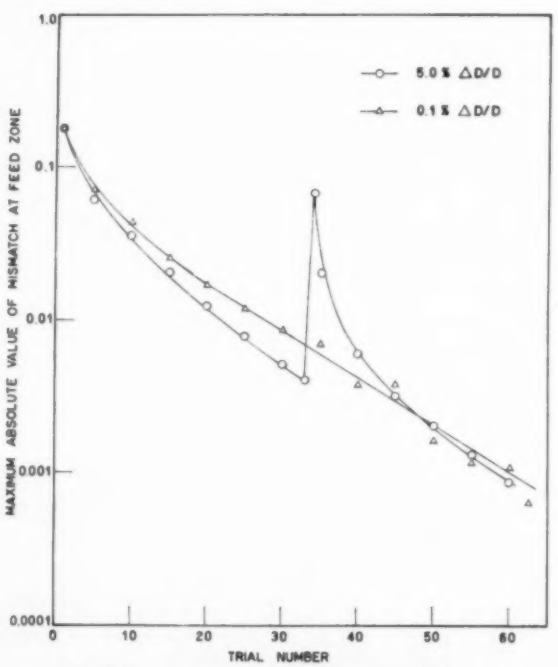


FIG. 3. Convergence curves for Deethanizer calculations.

TABLE III

COMPONENT	FEED MOLS/HR	DISTILLATE* MOLS/HR	BOTTOMS* MOLS/HR
C_1	14.14	14.12386	0.01164
C_2	7.63	6.93843	0.69157
C_3	13.15	3.40751	9.74249
iC_4	2.66	0.00018	2.65982
nC_4	7.90	0.00002	7.89998
iC_5	1.21	–	1.21000
nC_5	2.34	–	2.34000
C_6	2.71	–	2.71000
L.O. (C_{10})	48.26	–	48.26000

OPERATING CONDITIONS

PRESSURE	- 500.0 psia.	REFLUX RATIO	- 2.67::1
NUMBER OF STAGES	- 19.0	CONDENSER TYPE	- PARTIAL
FEED PLATE LOC.	- 12.0	FEED CONDITION	- 27.3% VAP. 355°F
△ D/D	- 5.0%	REFLUX TEMP.	- 17.62°F

HEAT BALANCES

HEAT IN*		HEAT OUT*	
FEED	- 27332907 BTU/HR.	CONDENSER	- 3229233 BTU/HR.
REBOILER	- 1,0007327 BTU/HR.	DISTILLATE	- 83632.5 BTU/HR.
		BOTTOMS	- 3,322,467.6 BTU/HR.

*MACHINE CALCULATED VALUES

Fig. 2 and 3 illustrate the trend of feed plate convergence for two typical problems. **Fig. 2** is for a debutanizer making a sharp split on a narrow range feed. In this case the machine assumed ideal split and profiles are good assumptions and very few trials are required. **Fig. 3** shows the same curve for two cases on a deethanizer. The general trend for these two towers is toward convergence, but the deethanizer requires more trials to adjust the initially assumed perfect split. The "average" tower would probably require 15-20 trials to converge to a mismatch of 0.001 mole fraction.

Fig. 3 also illustrates one possible consequence of variation in distillate tolerance specification. One step in the calculation sequence is a check to make certain the adjusted distillate rate is within the specified limits. If outside specifications, distillate composition is modified to bring the distillate back to the perfect split value. This causes a discontinuity in the convergence curve as is clearly shown by the 5%ΔD/D curve in **Fig 3.**The 0.1%ΔD/D curve shows the same discontinuity but with much smaller magnitude.

Table 2 presents the input data and calculated results for a debutanizer. The convergence curve is shown in **Fig. 2.** This represents a very simple problem for which nearly all machine calculation techniques will produce a satisfactory solution.

Table 3 presents the input data and calculated results for a deethanizer. The convergence curve for this problem is shown in **Fig. 3,** the temperature and vapor profiles in **Fig. 4.** The wide range of molar enthalpies (10::1) and relative volatilities (28,000::1) in this feed stream gives an indication of the flexibility and wide range for application of this program.

Fig. 5 shows the vapor rate and temperature profiles for a tower operating without external reflux. One program option alters the sequence of calculations to provide for calculation of towers of this type.

All of the calculations presented are based on physical property data from the 1957 Engineering Data Book of the Natural Gasoline Supply Men's Association.[7] These data are readily adaptable for machine usage.

The computer program described here has proved to be a reliable method for the solution of distillation problems and gives the design engineer a way of predicting difficult and unusual distillation separations.

References

1. Amundson, N. R., and Pontinen, A. J., *Ind. Eng. Chem.*, 50, 730 (1958).
2. Bonner, "Solution of Multicomponent Distillation Problems on a Stored Program Computer," presented at 21st Midyear Meeting of the American Petroleum Institute's Div. of Refining, Montreal, Canada, May, 1956.
3. Greenstadt, J., Bard, Y., and Morse, B., *Ind. Eng. Chem.* 50, 1644 (1958).
4. Lewis and Matheson, *Ind. Eng. Chem.* 24,494 (1932).
5. Lyster, W. N., Sullivan, S. L. Billingsley, D. S., and Holland, C. D., "High Speed Computing by Use of the Thiele and Geddes Approach to Multicomponent Distillation," presented at Salt Lake City Meeting of American Institute of Chemical Engineers, Salt Lake City, September, 1958.
6. Thiele, E. W., and Geddes, R. L., *Ind. Eng. Chem.*, 25, 289 (1933).
7. Natural Gasoline Supply Men's Association Engineering Data Book 7th Edition (1957).

Acknowledgment

The authors would like to express their appreciation to the Computing Center at Oklahoma State University for making available the computing time and the IBM 650 facilities necessary for this work and to thank DX-Sunray Oil Company for their fellowship grant to Mr. Erbar.★ ★

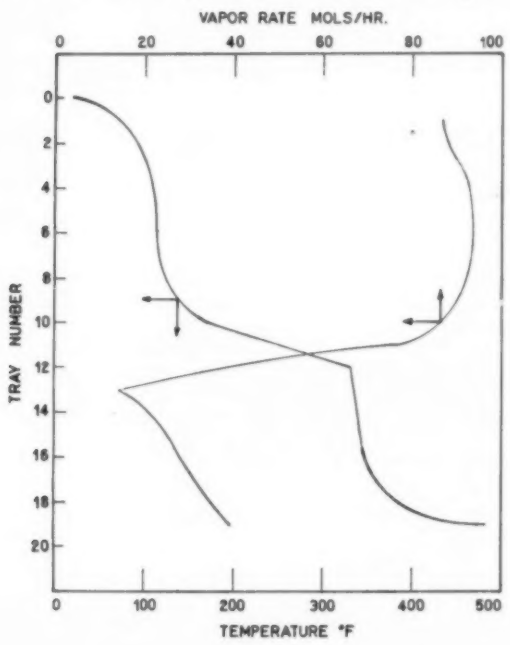


FIG. 4. Deethanizer temperature and vapor rate profiles.

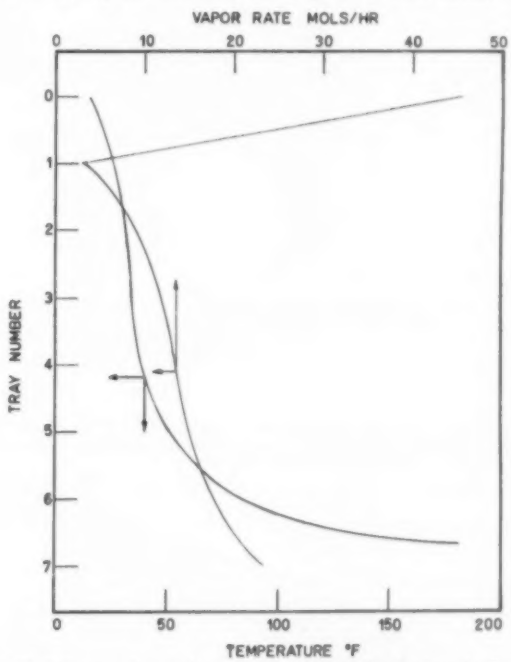


FIG. 5. Temperature and vapor rate profiles without external reflux.

1949

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

1959

# of better gasolines through

PLATFORMING®

Petroleum refiners throughout the Free World have already supplied motorists with nearly 50,000,000,000 gallons of

Platformed® Gasolines

This year marks an important anniversary . . . the anniversary of an announcement that made significant history throughout the petroleum refining industry.

In March of 1949, Universal announced an important achievement in the field of catalytic reforming. In October of the same year, the first Platforming unit was placed in operation at a Muskegon, Michigan refinery. The new process, Platforming, literally revolutionized the entire concept of processing to improve motor fuels. It made previous methods of refining completely obsolete.

In addition to its value in producing superior Platformed gasolines, Platforming has also proved highly efficient in producing aromatic hydrocarbons, thereby providing the basis for the great petrochemical developments which have since taken place.

The rest of the story is a matter of history. Though many improvements and modifications have since been made, the same basic Platforming process has been applied by refiners throughout the Free World, and now accounts for a large proportion of all the reforming carried out today.

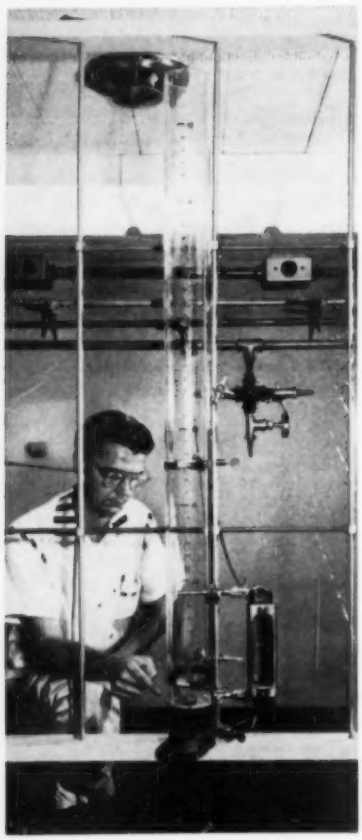
UOP®

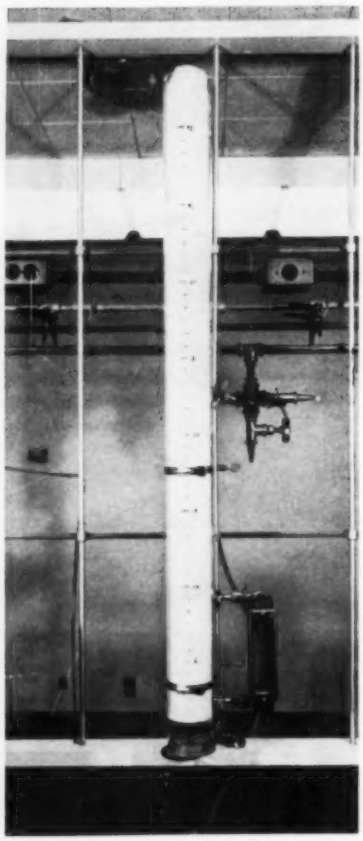
UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U.S.A.

New Equipment

Foam Cleanser

- Increases Efficiency
- Decreases Costs





Shaving lather machines in the corner barber shop now have a big brother helping to clean equipment in various industrial plants. Research chemists for the Dowell Division of The Dow Chemical Company have announced a method of making a chemical lather that may revolutionize cleaning of industrial equipment.

A small amount of chemical can be expanded more than 50 times its original volume. At left is shown the level of chemical in the tube. At right the chemical foam fills the tube. In normal operation, average ratio of foam to solvent will be about 20 to 1.

Unique apparatus is used for making the chemical lather. The foam solvent is pumped from this apparatus directly into the tank, pipe or tower to be cleaned. When the vessel is filled with chemical foam, the process continues with foam passing into a foam breaker and a filter which removes the material dislodged by movement of foam through equipment. Solvent is then recycled through the foam generator and unit being cleaned. Routine tests tell when the job is finished. New method promises to provide answers to many cleaning problems formerly too expensive to perform with liquid solvents, or not possible with older methods.

Foam solvent makes it possible to . . .

- Clean large volume systems with small amount of liquid,
- Clean equipment that would not stand weight and hydrostatic pressure caused if liquids were used,
- Use concentrated chemical solvents where needed,
- Remove readily sloughed materials because of excellent particle-carrying property,
- Reduce waste disposal problems because smaller quantity solvent is used,
- Clean complex equipment because solvent fills every loop and bend, every nook and cranny, reduce transportation costs because of lighter weight and smaller volumes,
- Tailor-make cleanser for nearly every type deposit, and
- Eliminate after-rusting problems because cleaned surfaces are not exposed to air since solvent is displaced directly with foam rinse or flush followed by foam passivator.

Important feature of the chemical service is ability to regulate density of foam with a densitometer which monitors and records density continuously.

Method is now being considered for use in all industries where heat exchange, process equipment and pipelines require cleaning.

Circle number (41) on reply card.

Automatic Meterman

Patented device for automatically changing circular recording charts is available. The Automatic Meterman affords utilization of as many as 40 circular charts in a single recorder; disengages the charts, one by one, at virtually any desired time/date frequency; and drops them by gravity into a self-contained storage box. Method uses only a minute portion of available clock power. Any number of field or plant recorders can be serviced without manual attention, at the identical moment, thus making it possible to correlate charts with master meter charts without multiple computations. Equipment is designed for use on all standard recorders using circular charts of any diameter or thickness. *Maeder-Squier Co.*

Circle number (42) on reply card.

Steam Turbines

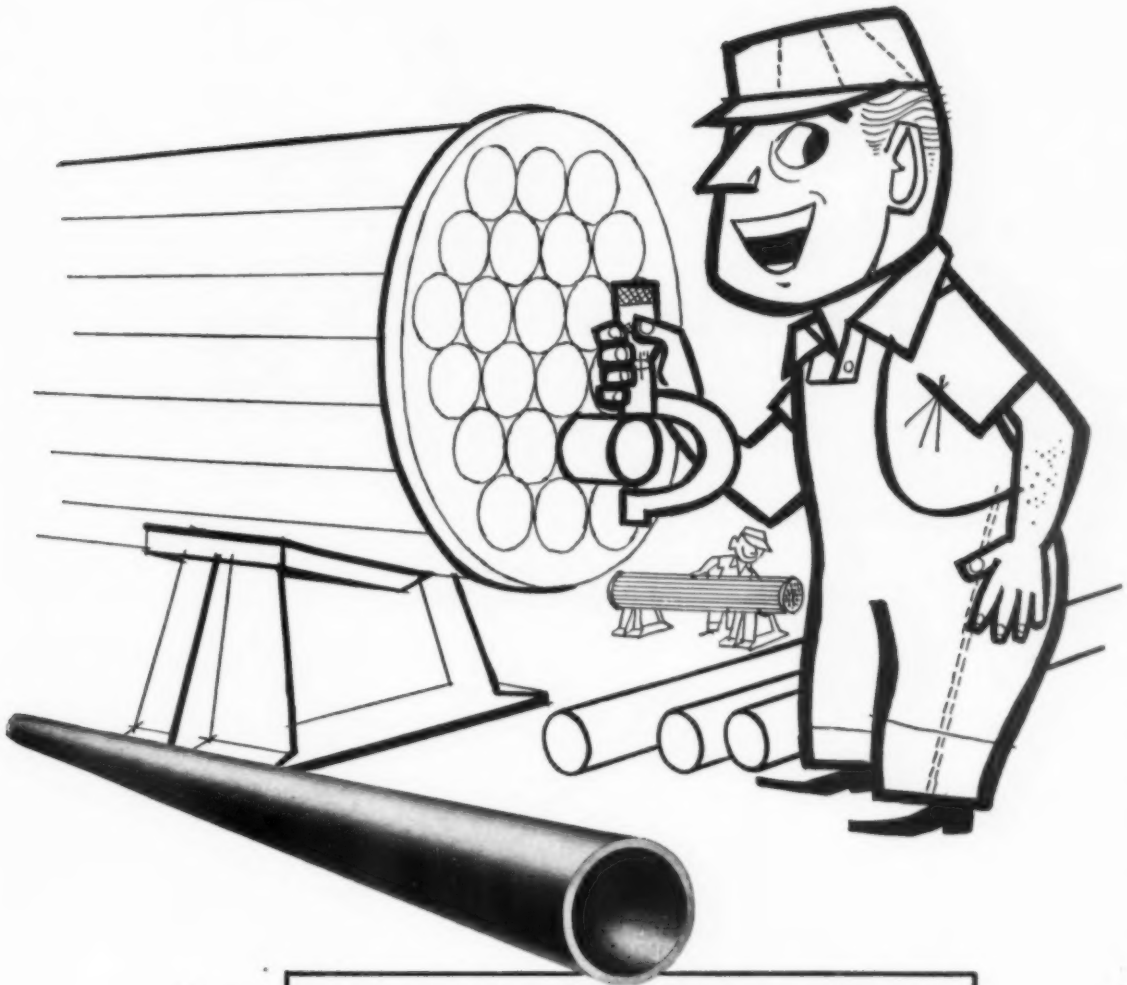
Pre-engineered, single-valve, multi-stage mechanical drive turbine specially designed to permit significant price reductions to meet petroleum and chemical industries' requirements, is now being offered. Designed for pump and compressor drive applications, this line utilizes "building blocks" components to reduce engineering and manufacturing time cycles. Prices start at 15 percent lower than handbook levels previously offered by General Electric's Small Steam Turbine Department. Applicable to the following conditions: 500 to 4000 hp, 4000 to 10,000 rpm, condensing or non condensing, throttle pressure, 100 to 850 psig, and temperatures to 900 F. *General Electric Company.*

Circle number (43) on reply card.

Improved Fractionator Control

Reflux computer controller for improving efficiency of fractionating towers and other distillation facilities is on the market. Using standard electric and pneumatic instrument components, the device is said to be most efficient means yet devised for determining and controlling internal reflux flow rate. Contains a 0-15 psi test gage on a 4-position selector switch so that a check can be made on all pneumatic signals. One variation available is with a fixed range thermocouple-to-pressure transmitter, the other with an adjustable range. Advantages said to result in substantial savings. *Manufactured and marketed by Brown Instruments, division of Minneapolis-Honeywell Regulator Company on license from Phillips Petroleum Company.*

Circle number (44) on reply card.



How B&W JOB-MATCHED TUBES meet Heat-Exchanger requirements

With B&W Job-Matched Heat-Exchanger Tubes you get:

- . . . tube tolerances and mechanical properties, controlled for ease of fabrication
- . . . a wide range of steels to meet any set of operating conditions
- . . . a complete range of tube sizes, for any type of heat exchanger

This means ease of fabrication to the heat-exchanger manufacturer — long service life to the heat-exchanger user—and ease of tube replacement to those concerned with maintenance.

For complete information about B&W Job-Matched Heat-Exchanger Tubes call the local B&W District Sales Office or write for Bulletin TB-329. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

CHEMICAL SHOW • Booth 1002
Coliseum • New York
November 30–December 4

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

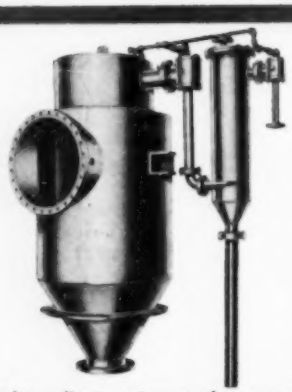
TA-9002-SPI

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

Nulli Secundus!

Graham 6 stage ejector capable of maintaining 4 microns absolute and handling 40,000 cu ft/min.

Single stage jet used on a 2 stage evaporator functioning as a thermo-compressor.



Graham direct contact condenser and 2 stage ejector—all of stainless 304 material.

Thank you, Brutus, old boy, for the right words! And, just as you say, the Graham Steam Jet Ejector *is* "second to none".

We have recently completed an extensive development program in our Batavia, New York engineering laboratory which has resulted in *added improvements* to the already high performance of Graham Steam Jet Ejectors. Design refinements worked out in this investigation mean increased stability, dependability and economy.

We now offer you the *finest performance available* from one to seven stages—a few inches of vacuum down to one micron of absolute pressure—evacuating small or large loads. Yes, Graham Ejectors are truly "second to none".

More information is contained in our Bulletin No. 70A. Send us your inquiries.

GRAHAM MANUFACTURING CO., INC.

Heliflow Corporation

170 GREAT NECK ROAD, GREAT NECK, N. Y.

Offices in principal cities and Canada

Pipe Plugs of "Delrin"

The incentive: Improved product design at less cost, has resulted in "Delrin," a tough, rigid thermoplastic developed primarily for use in fields now dominated by die-cast metals. Over 75 percent of its potential applications involve replacement of steel, brass, aluminum and zinc. Among likely uses are industrial pipe plugs in which the strength and resilience of the acetal resin are combined with its

corrosion resistance and easy fabrication to make plugs of many head and thread designs. Seals against pressures as high as 10,000 psi have been achieved in field tests. Even after repeated cycling from room temperature to 250 F, pressures of 500 psi were held consistently. Plugs are virtually self-locking even at low installation torques.

"Delrin" retains its properties of being rigid, rough and resilient under adverse conditions of temperature and humidity, during an extended time under stress, and during exposure to most solvents. It is tasteless, odorless, non-toxic and lighter than any die-casting alloys. It will sell initially at 95 cents per lb, and will be subject to reduction as production volume increases. "Delrin" emerges as a strong competitor in terms of final cost of the product. Two major compositions will be offered: "Delrin" 500 acetal resin for general purpose molding, and high-viscosity "Delrin" 150 for extrusion (tubing, sheeting, rod for machining, etc.) *E. I. duPont de Nemours & Company.*

Circle number (45) on reply card.

Clark Introduces 4000 bhp 2-Cycle, V-Engine . . .

Turbocharged, 2-cycle gas engine, designated Model TPV, is designed as a compact, high hp driver for centrifugal compressors in pipeline booster stations, for power generation and for pump drive.

Featuring 17 by 19-in. bore and stroke, the engine will be built in 3 sizes — 10, 12 and 16 power cylinders — rated at 4000, 4800 and 6400 bhp respectively. Combines low fuel consumption with known simplicity, reliability and low maintenance costs inherent in 2-cycle design. Will operate at about 40 percent thermal efficiency. *Clark Bros. Company.*

Circle number (46) on reply card.

Gage Alarm Control

The Varec Slack Take Alarm Control enables either an operator of a remote gaging system or a tank gager, reading an automatic tank gage, to immediately detect a broken tape or any abnormal slackening of the tape at the time of reading, and thus reject the reading at the receiver or ignore it at the gage head. Construction is simple throughout. Mercury switch is held in position by an arm attached to an idler pulley that rides against the gage tape. Should the tape break or become abnormally slack, the Mercury switch will tile to either an open or closed (depending on which is normal for the particular installation) position. Either visual or audible alarms or any other signaling device may be wired into the switch. Control mechanism is contained in an "in-line" housing fitted with 1½ NPT connections. Price: $140 each, f.o.b. Compton, California. Shipping weight: 30 lb. *The Vapor Recovery Systems Company.*

Circle number (47) on reply card.

Plastic Sleeve

Ease of installation, thermal and chemical resistance, flexibility and long service

life are some outstanding features of a plastic coil sleeve. It serves as a protector for various hoses ranging in size from ¼-in. to 2 in. in diam. For hoses up to ⅝ in. diam, sleeve is supplied in coils up to 50 ft in length, and for larger size hose, in 25-ft lengths. The lightweight sleeve is unaffected by air, water, oil, gasoline and most other fluids, including hydraulic oils. Retains shape and flexibility under temperature conditions from –20 F to 200 F. *Aeroquip Corporation.*

Circle number (48) on reply card.

Expansion Joints

Complete line of pressure-balanced expansion joints for absorbing pipeline movement without imposing pressure thrust has been announced. Installed at elbows or points where piping changes direction, the joints use a counterbalancing outer bellows to absorb line pressure where anchoring is not practical. Available in diameters from 3 in. to 50 ft for temperatures from –320 F to 1600 F and pressures up to 2500 psi. Special units are available for more severe conditions. *Zallea Brothers.*

Circle number (49) on reply card.

Fork Lift Truck

"Pace-Maker" Model 680-P Fork Lift Truck is available in 5 different heavy-duty models with either cushion or pneumatic tires, and lifting capacities ranging from 3 to 6 tons. Features a simplified method of fork suspension that permits fast, easy adjustment—for handling loads of various size and type; plus fast "interchangeability" of standard forks with wide assortment of cost-cutting accessories. Engine compartment side panels are slip-socked for removal without tools in less than 30 sec. Cool-Flow exhaust system with specially-engineered spark and flame arrestor is standard on the entire Pace-Maker series. *Towmotor Corp.*

Circle number (50) on reply card.

Stainless Steel Plug Valves

A new line of four and five port Tufline stainless steel plug valves — suited for wide range of services — has been introduced. Incorporating Teflon sleeves, which require no lubrication, the valves give assured operation without seizing in any

position. They are available in the 150 lb class from ½-in. through 2-in. sizes, with both flanged and screwed ends. Because of their multi-port design and non-lubricating feature, users can effect savings through the resulting reduction of maintenance and minimizing of number of valves required to achieve multiple flow paterns. Internal ribbed construction locks the sleeve in position while allowing for sleeve expansion and contraction without leakage. Valves provide trouble-free service over temperature range — 150 F to 400 F and pressures from high vacuum to 275 psi. They come with bodies and plugs of 316 stainless and Alloy 20, and carbon steel bodies with 304 stainless plugs. Can also be ordered in aluminum, bronze, Hastelloys, monel, nickel and 304 stainless. *Continental Manufacturing Company.*

Circle number (51) on reply card.

Anti-Dust Dye

Granulated oil red dye that eliminates dusting problems in storage and handling has been developed for use by refiners who color gasoline. Known as Calcogas Rocket Red, this new dye is non-dusting, non-caking and very soluble. Granular form facilitates its use in automatic metering and mixing equipment. Resists change of physical state even at elevated temperatures often found in refinery storage areas. *American Cyanamid Company.*

Circle number (52) on reply card.

Recorder-Controller

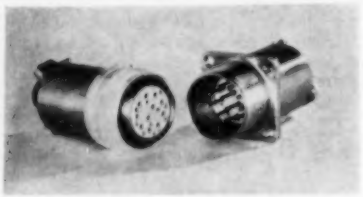
Recorder-controller combination—capable of replacing up to six individual recording-controlling units, and designed for high performance installations, consists of a multipoint recorder and controller — reduces initial costs, saves valuable panel space, and offers increased flexibility in controlling up to 6 points and recording up to 24 points. Features ability to operate from one or two separate thermocouples or other inputs per point. *Daystrom-Weston Sales Division, Daystrom, Incorporated.*

Circle number (53) on reply card.

New Equipment

Thermocouple Connector

Miniaturized thermocouple connectors are available with ceramic inserts designed to withstand temperatures up to 1000 F and can be used in power as well as thermocouple circuits. Present models come in 5, 9, and 11 contact configurations with a shell of 1¼-in. OD. Pins and sockets are available in chromel, alumel, copper, constantan and iron with welded, soldered or brazed connections for up to number 14 wire. *Harco Laboratories, Inc.*



Circle number (54) on reply card.

For The Sportsman

. . . an outboard motor oil especially designed to meet lubrication needs of today's high output, 2-cycle engines. Result of intensive program of testing current model 35 and 40 hp engines under conditions calculated to present critical lubrication problems. It has been proved to:

1. Reduce spark plug fouling.
2. Minimize ring sticking and piston varnish.
3. Change characteristics of combustion chamber deposits to dry flaky material that is harmlessly purged through the exhaust system.

Available in one quart and 8-ounce containers. *Phillips Petroleum Company.*

Circle number (55) on reply card.

Sky Climber . . .

Climbs the wire rather than spooling the wire on the drum, therefore: No restriction as to length or height of job, no build-up of wire on drum, light weight and easier handling, unique reeving method eliminates crossover of wire, complete convertibility from manual to electric to air power. Safe working load — 1000 lb per unit. Conforms to all known safety regulations. *Western Gear Corporation, Industrial Products Division.*

Circle number (56) on reply card.

Low-Voltage Substations

Low-voltage power-zone package unit substation is available for use on 480 v systems to supply 120/208Y circuits. Designed for lighting, office equipment and similar loads, substations contain 3-phase transformers from 75 kva to 300 kva. Up to 72-in. of panel space is available for molded case circuit breakers. Dimensions of 60 in. long, 36 in. deep and 79½ in. high, provide easy movement through commercial doorways, minimize installation space. Open-ventilated dry-type transformers are designed for quiet operation. Sound levels have been reduced to 45 db for sizes up to 150 kva, 52 db for 225 kva and 56 db for 300 kva. *Square D Co.*

Circle number (57) on reply card.

25:1 Speed Reducers

Expanded line of shaft-mounted speed reducers includes a 25:1 double reduction series in 8 sizes. Both 15:1 and 25:1 gear ratios are now available in housings of identical dimensions and at the same price. Output speeds range from 12 to 400 rpm. New 25:1 units will give 40 percent lower output speeds with identical motor speeds and V-drive ratios. Giant of the series is size TD11 described as the world's largest shaft-mounted speed reducer offered from stock. Its reduction ratio is 24.73:1 and it is rated at 154 hp at 75 rpm. Improved method of attaching torque arm to reducer case employs saddle-type bracket for greater strength and better balance. *Dodge Manufacturing Corporation.*

Circle number (58) on reply card.

Electronic Messenger

Paper work, records, documents, orders, etc., can now be sent by a new electronic facsimile unit over either leased wires or by micro wave as easily as making a telephone call. With the Electronic Messenger communications, whether printed, typed, written or drawn, can be transmitted and reproduced to other stations in the system. An electric eye scans material and sends electrical impulses over telephone lines, direct wire or microwave to duplicate the original message on one or more companion machines anywhere . . . in the same building or hundreds of miles away. When not sending, the machine is ready at all times to receive communications. *Electronic Communications, Inc., Facsimile Equipment Division.*

Circle number (59) on reply card.

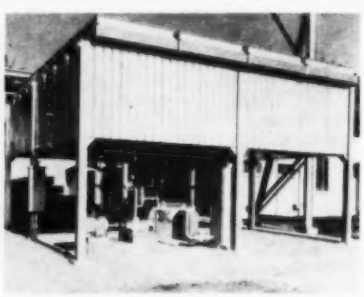
Fire-Fighting Attachment

Installed on fixed-roof liquid storage tanks, device known as the "Puncture Plate" admits light and air to the tank interior during maintenance work. In addition, it facilitates use of hydraulic towers in case of fire. It is a steel assembly holding a strong plastic sheet or "skylight" which, though vaporproof, is readily penetrated by the gooseneck of the foam tower. With the plastic sheet in place, the Puncture Plate makes it easier to reach the burning surface of the liquid. Men assigned to steaming and cleaning operations can work in greater comfort and safety. Tanks can be returned to service far sooner, and cost of maintenance is reduced. *National Foam System, Inc.*

Circle number (60) on reply card.

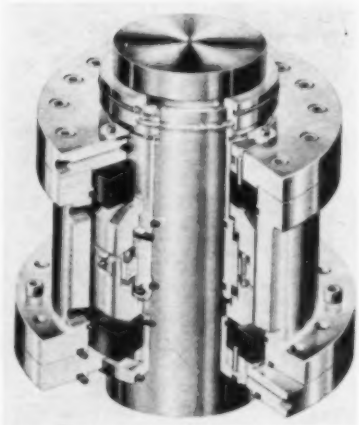
Heat Exchange Unit

Truss-type structure is reported to be more economical and stronger and has functional beauty that blends perfectly with other installations. Every detail has been designed to provide easy erection and maintenance-free operation. Equipped with 4 to 1 safety factor using a 30 lb per sq ft wind load which enables it to withstand winds of hurricane velocity and earth quakes. *Arrow Industrial Manufacturing Company.*



Circle number (61) on reply card.

Agitator Shaft Seals



New series of mechanical seals developed for installation on sealed vessel agitator shafts, are completely self-contained in single unit for simple, quick installation. Designed to prevent agitator shaft leakage at pressures up to 3000 psi and to withstand leakage in excess of 700 F, even in corrosive environments. Available in sizes to fit any shaft. *The Garlock Packing Company.*

Circle number (62) on reply card.

Self-Draining Valves

Improved self-draining valve utilizes a special-type bolted bonnet which guarantees perfect alignment and "freeze-proof" action under all conditions. Said to be ideal for installations where it is desirable to have the valve seat inside the wall of the pipe or vessel to prevent liquid from remaining in the area between the liquid container and the valve seat when the valve is shut. Unique design allows valve stem to work freely at all times and prevents any possible freezing. Recommended for pressures up to 4000 lb at 100 F, or 1000 lb at 750 F for ¾ in. and 1 in. size. Other sizes available are 1, 1½ and 2 in. *Jerguson Gage & Valve Co.*

Circle number (63) on reply card.

Multi-Stage Compressors

High speed multi-stage centrifugal compressors in a simplified compact and rugged design are engineered for gas compression applications including fractionation, liquefaction, chemical reaction storage and refrigeration. The Turbomaster Compressors have about 400 fewer parts than conventional centrifugal compressors. Shaft design combines extra stiffness for minimum deflection and vibration in the rotor areas. Available from 2 to 8 stages in a simple casing. *York Corporation, a subsidiary of Borg-Warner Corporation.*

Circle number (64) on reply card.

King-Size Vacuum Pump

Mechanical booster vacuum pump stands 83¼ in. tall, occupies area 103 in. by 67 in., and has maximum displacement of 6370 cu ft per min. Is compact 2-stage high-speed pumping units, consisting of a high-capacity Roots-type dry blower as the first stage, backed by a gas-ballasted rotary piston-type mechanical vacuum pump capable of very fast roughing as the second stage. *F. J. Stokes Corporation.*

Circle number (65) on reply card.

SERIES 60—normal needs, pressures to 400 psi, 6 sizes. **SERIES 120**—normal needs, pressures to 600 psi, 6 sizes. **SERIES 40**—for extra heavy loads, 5 sizes. **NO. 30**—for extra light loads (½" only). **INTEGRAL STRAINER**—highest pressures and marine use, 6 sizes.

NEW NO. 30 IS A LIGHT LOAD SPECIALIST

When the condensate load in your steam lines is *extra light*—this new Yarway ½" No. 30 Steam Trap is *exactly right*.

Specify it. You'll experience new *economy of operation* with the *tighter shut-off*. Operation is *quieter* due to lever action. *Maintenance is less*—because of the replaceable valve-seat assembly, only one moving part and stainless steel construction. Enjoy these special features plus all the regular advantages of famous Yarway Impulse Traps such as *quick heating, even temperatures, small size, good for all pressures, non-freezing.*

Over 1,250,000 Yarway Impulse Traps already sold; buy yours from one of 270 local Industrial Distributors.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.

YARWAY *impulse® steam traps*

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

single

STEP

to profitable processing

If you're familiar with the one-step Houdry Dehydrogenation Process, you know the source of profit for a large share of this country's butadiene production capacity. Since the major expansion of the synthetic rubber industry began in 1955, more than 300,000 ton/yr of new capacity has been installed by Houdry licensees using this process for transforming butane to butadiene.

Don't get the idea though, that you have to make synthetic rubber to enjoy the advantages of the Houdry Dehydrogenation Process. It is also highly efficient for transforming butane to butenes, isobutane to isobutene, and other light hydrocarbons to mono- and di-olefins.

Simple . . . flexible . . . profitable. That's the Houdry Dehydrogenation Process. And it has these three very important characteristics because Houdry people designed it that way, and made it deliver.

They can do the same for you.

*

HOUDRY

PROCESSES

HOUDRY PROCESS CORPORATION

1528 Walnut Street, Philadelphia 2, Pa.

*Houdry means Progress . . . through Catalysis

REFINING PERSONALS

▸ Four top executives of Stone & Webster Engineering Corporation who have

H. F. Cleary

D. N. McCord

been elected vice presidents are: **Harold F. Cleary** and **Donald N. McCord,** construction managers; **M. H. Cutler,** engineering manager; and **William R. Prang,** West Coast district manager.

M. H. Cutler

W. R. Prang

▸ **Frederick John Ludwig,** research chemist for Mallinckrodt Chemical Works, Uranium Division, has joined Petrolite Corporation's research department in St. Louis, Missouri. Ludwig obtained his PhD in chemistry from St. Louis University.

▸ Promoted to assistant operating manager of the El Paso Natural Gas Products Company is **Mack Atcheson,** former chief engineer, who will be succeeded by **Virgil A. (Nick) Johnson.** Atcheson joined

Mack Atcheson

V. A. (Nick) Johnson

the El Paso Natural Gas Company in 1949 and became associated with the Products Company in 1956. Johnson joined the company in 1957 as a senior engineer and was promoted to assistant chief engineer in 1958.

▸ **W. R. Wyatt** has been named superintendent of Shell Oil Company's Weeks Island, Louisiana, natural gas and processing plant. Prior to this assignment, Wyatt was assistant plant superintendent of Shell's Sheridan, Texas, cycling plant.

▸ **Kenneth M. Brown,** Universal Oil Products Company technical service engineer, has been named by ASTM committee D-16 to head a subcommitee establishing international specifications for aromatic hydrocarbons. The subcommittee will work through American Standards Association with the International Standards Organization to set up purity specifications and testing methods for benzene, toluene, xylene and other aromatics derived from coal tar and petroleum. Brown, a 21-year veteran with UOP, has been the company's representative to ASTM's committee concerned with aromatic hydrocarbons since 1950.

▸ Election of **Robert K. Dix** as a vice president has been announced by the Enjay Company. The former assistant general manager of Esso Standard's Baton Rouge, Louisiana, refinery, will head Enjay's products management department succeeding **H. J. Rose,** who resigned recently to become a vice president of Esso Export Corporation, international marketing affiliate of Standard Oil Company (New Jersey).

▸ Financial vice president, treasurer and member of the board of directors of Clark Oil & Refining Corporation is **Owen L. Hill.** He was formerly secretary-treasurer of Seaboard Oil Company in Dallas, Texas, until Seaboard was acquired by Texaco, Inc. in 1958, when he was transferred to New York.

▸ New first scientific advisor for Sun Oil Company is **Dr. Charles L. Thomas,** holder of more than 100 patents, who will

Dr. C. L. Thomas

Dr. R. M. Kennedy

furnish scientific leadership in research and engineering and pursue his research specialties. **Dr. Robert M. Kennedy,** who holds about 40 patents, succeeds Dr. Thomas as director of research and development.

▸ **Raymond M. Camp** was named superintendent of crude, cracking and coking operations and **Eugene Andrechak** appointed superintendent of economic planning and accounting, Tidewater Oil Company. Camp was in Delaware as superintendent of alkylation, polymerization, reforming and desulfurization. Andrechak was acting superintendent of economic planning and accounting.

▸ Appointment of **Dr. Kenneth J. Radimer** as research chemist has been announced by The M. W. Kellogg Company. Formerly employed by CBS Laboratories, Dr. Radimer will be assigned to the exploratory research group at Kellogg's laboratories.

▸ Election of **E. O. Buck** to the board of directors of Texas Petro Gas Company of Houston, Texas, has been announced. Buck is senior vice president of The National Bank of Commerce in Houston.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Personals

▸ After serving 33 years as head of the Inspection Laboratory at Humble Oil &

P. L. DeVerter

J. C. Gorman

Refining Company's Baytown, Texas, refinery, **P. L. DeVerter** has retired. **J. C. Gorman** has been named foreman of the laboratory.

D. M. Haas and **H. M. Stewart,** engineering associates in the technical divi-

D. M. Haas

H. M. Stewart

sion at Baytown, have retired under Humble's retirement plan.

▸ **Verne L. Snow** has been elected a vice president of The Refinery Engineering Company of Tulsa, Oklahoma, a division of Vitro Corporation of America. Snow will continue as manager of Treco's Four Corners Division, located in Farmington, New Mexico, a post he has held since shortly after the division was formed in early 1958.

▸ **Dr. H. A. Holcomb** has been promoted to research specialist in Humble Oil & Refining Company's Research and Development Division at Baytown, Texas. He is now serving in the company's executive development program in charge of the section engaged in research on corrosion, waste disposal and electric discharge reactions. Humble has also promoted **W. A. Morgan** to senior research physicist in the Research Development Division. He is engaged in the design and development of electronic equipment for control systems.

Newcomers to the division are: **K. W. Bartz, L. R. Harrington, J. R. Hopper, M. S. B. Munson, J. A. Planchard, E. E. Poirot** and **A. T. Watson.**

▸ Two senior planning associates have been added to The Ohio Oil Company's forward planning division. They are: **F. H. Warren,** former manager of the supply and transportation planning department, and **N. E. Trumbull,** former assistant manager of Ohio Oil's Casper, Wyoming, production division. In their new positions they will conduct comprehensive studies and evaluations to assist management in establishing long-range goals and plans for the company and its operating functions.

▸ Universal Oil Products Company has appointed **Dr. L. G. Massey** as head of the UOP computer department. Dr. Massey has been assistant head of the department since 1957, having joined Universal's pilot plant division in 1951.

EQUIPPED FOR SERVICE

The more ways a company can serve you, the better will be your opportunity to use it profitably. And here's a service organization experienced in not just one, but *three* fields . . . petrochemical, chemical and petroleum processing.

Suppose you want to test a process without disrupting work you may now have in progress. Call on HOUDRY Contract Service for facilities and experienced manpower. Assign to HOUDRY the job of developing your ideas, and testing them in pilot plant operation.

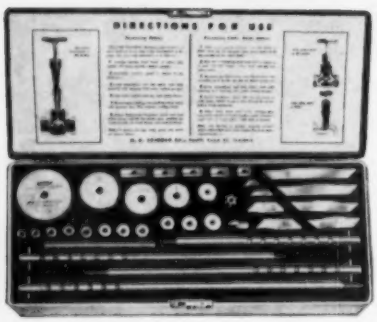
Then, if you wish, HOUDRY can assist you in commercializing your process. Or, if you want to improve the performance of a processing plant now on stream, HOUDRY can bring you the benefits of the newest advances in processing and catalysts, and experienced service in every phase of chemical, petrochemical and petroleum processing.

In short, if your company is at all concerned with these fields, you will find HOUDRY equipped, willing, and highly able to serve you well.

*HOUDRY PROCESS CORPORATION
1528 Walnut Street, Philadelphia 2, Pa.
*Houdry means Progress . . . through Catalysis

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

RESEATS VALVES and BIBBS QUICKLY ECONOMICALLY



Easily pays for itself on the first two jobs!

Reseats flat and tapered-seat globe or angle valves —all bibbs and faucets— in place, quickly and accurately. The saving, over tearing out and renewing leaky valves and fixtures, is tremendous.

Cutters operating under screw feed, leave worn, scored seats glass-smooth, level, absolutely accurate and tight.

A guide pilot centers each cutter; a tapered cone centers each spindle. Perfect alignment is inevitable. Cutters guaranteed. Write for literature!

2" for ¼" to 2" valves and ¼" to ¾" bibbs
List price $59.85

3" for ¼" to 3" valves and ¼" to ¾" bibbs
List price $79.50

FREE catalog showing our pipe repair clamps, saddles, and reseating tools

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

Personals

▸ **Ben A. Burdette** was appointed mechanical engineering supervisor at the Augusta, Kansas, refinery of Mobil Oil Company. Burdette worked in the engineering department at the refinery from 1945 to 1953 when he became stores department manager. In 1955, he was appointed chief project engineer and was transferred to assistant employee relations manager in 1958.

▸ Elected a member of Tidewater Oil Company's board of directors is **Herschel Y. Hyde,** group vice president for manufacturing, marketing and petrochemicals. Hyde joined Tidewater in 1928 as research chemist, was elected vice president of manufacturing for the western division in 1946, and in 1954 was named head of all Tidewater refining operations. He was just recently named group vice president.

▸ **Charles A. Cogan** has been named assistant manager of the operations division in the manufacturing department of Standard Oil Company (Indiana). He was assistant manager of the company's Casper, Wyoming, refinery before transferring to the general office at Chicago.

▸ Four college professors served as consultants and conducted research and engineering studies with Humble Oil & Refining Company at Baytown, Texas, this summer. In Technical Division **Dr. L. W. Morgan,** associate professor of petroleum refining engineering at Colorado School of Mines, worked and consulted on problems in instrumentation and control, and **Dr. J. B. West,** associate professor of chemical engineering at Oklahoma State University, in extraction processes for lubricating oil manufacture. In Research and Development division **Dr. R. F. Curl,** assistant professor of chemistry at Rice Institute, consulted and conducted research on problems in molecular spectroscopy, and **Dr. H. F. Rase,** associate professor of chemical engineering at The University of Texas, on problems in catalytic cracking, aromatization and reforming.

▸ **Eric S. Pfefferkorn** succeeds **Clare O. Bryant,** who has retired after 42 years of service, as manager, personnel and labor relations, at The California Oil Company. Pfefferkorn joined Caloil in 1956 after 20 years in petroleum marketing with Standard Oil Company of California.

Other management appointments are: **B. S. Gandek,** chief accountant; **F. W. Gaudet,** office manager; and **K. F. Keenan,** supervisor, forecast, profit analysis and taxes.

▸ **William G. Swartz Jr.** has been elected a vice president of Cities Service Oil Company (Pennsylvania). Manager of operations and manufacturing for Cities Service, Swartz joined the company in 1947 as a junior engineer. After serving in the operating department in Chicago and as regional superintendent of operations in Kansas City, he was moved to New York in 1955.

▸ **Winthrop M. Barnes** has been appointed assistant director — petrochemicals of Sun Oil Company's Research and Development Division. He succeeds **Dr. Raymond Wynkoop** who was appointed manager of Basic Research earlier this year.

Prior to joining Sun, Barnes was research manager of the Department of Industrial Economics at the Southwest Research Institute in San Antonio, Texas.

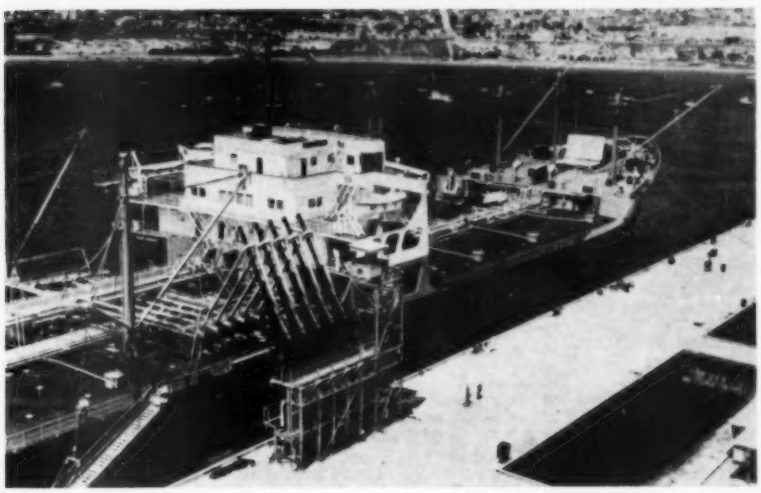
FOR SEALING THE UNUSUAL...

DURA SEAL

...provides mechanical sealing for the widest range of pressures, temperatures and speeds

Technical information on request — write **DURAMETALLIC CORP., Kalamazoo, Michigan**

World's First Dockside Supertanker Terminal



Large enough to handle ships up to 75,000 tons, a dockside supertanker terminal has been opened by Port of Los Angeles and Union Oil Company of California. Built at a cost of $4,000,000 by the Los Angeles Harbor Department, the terminal will be operated by Union Oil under a 30-year preferential assignment. The agreement stipulates that any oil company bringing supertankers into the municipal port may use the new terminal.

New facility which has capacity of 35,000 bbl per hr of crude oil, makes it possible for even the largest supertankers to come right up to the side of a wharf for the entire unloading operation thereby eliminating dangers inherent in open water unloading as well as speeding the process. Usually, huge ships are unloaded by floating pipeline while they ride at anchor some distance from shore. Another common practice is to transfer part of their cargo of crude oil to a smaller tanker until they are light enough to move in closer to shore where higher capacity pumping apparatus can be connected.

Built to handle ships up to 75,000 tons deadweight drawing up to 46 ft of water, the terminal was designed, according to Admiral E. V. Dockweiler, so that it can be deepened to 55 ft to accommodate ships in excess of 100,000 tons.

Tankers berthed at the new terminal are unloaded by an automated system that allows one man to unload up to 35,000 bbl of crude an hr at the touch of a single button. Located on the dock for this purpose are 5 hydraulically operated loading arms which swing out to join the tanker's pipelines.

Transfer of crude is through a 30-in. pipeline which connects the tankers with a nearby tank storage farm and a Union Oil Company refinery 4 miles away. The tank farm consists of five 175,000-bbl tanks — among the largest built in the United States.

Terminal stands on an 18-acre manmade peninsula. Wharf is of reinforced concrete and including outboard dolphins located at either end, affords an over-all length of 1160 ft.

for **leakproof, pressure-tight connections**

USC TiteSeal®

SEALING COMPOUNDS

Heat and vibration-proof, non-solvent, will not shrink, crack or crumble. Makes all assemblies leak-proof and pressure-tight. Prevents rust, corrosion, joint seizure.

7 BASIC BLENDS

LIQUID WRENCH®

The super-penetrating rust solvent

LOOSENS

rusted bolts, nuts, screws, 'frozen' parts

Liquid Wrench works *fast*...yet is absolutely safe for all metals and alloys.

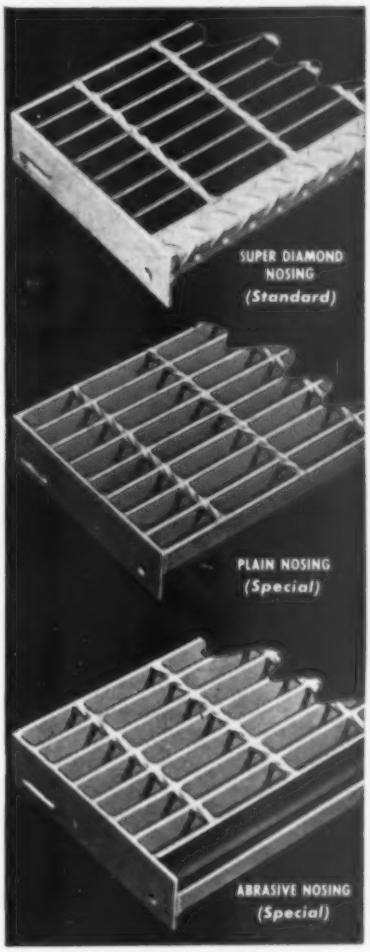
2171

At Industrial, Automotive, Hardware, Plumbing Jobbers

SOLDER SEAL

RADIATOR SPECIALTY CO.
Charlotte, North Carolina

FOR PLANT SAFETY AND ECONOMY SPECIFY KERRIGAN Weldforged GRATING & TREADS



Note how spirals in cross bars alternate right and left and are slightly raised above bearing bars for an extra margin of safety.

SEND FOR FREE CATALOG

Address Dept. P-9

KERRIGAN IRON WORKS CO.

Nashville 2, Tennessee

REFINING LITERATURE

Molecular Sieves Bulletin

How chemicals are stored in molecular sieves is explained in booklet issued by the Linde Company. It indicates various established uses of this ability, sorts of chemicals that can be loaded, outlines a typical case history and shows how extremely volatile di-tertiary butyl peroxide was loaded to advantage as a catalyst in the manufacture of vinyl-containing silicone rubber. Other uses for chemical-loaded molecular sieves are suggested and a questionnaire through which additional data can be obtained, is included. *Linde Company, division of Union Carbide Corporation.*

Circle number (66) on reply card.

Revised Insulation Manual

Well-known manual of insulation specifications has been released in enlarged and thoroughly revised form. Procedures are in accord with modern practices and specifications include new insulations. Organized for convenient reference, manual has attractive new cover, easy-to-read format and includes photos to clarify text or exemplify procedures to be followed. *Johns-Manville.*

Circle number (67) on reply card.

Packaged Boiler Brochure

Complete discussion of packaged fire-tube boilers — from construction features to final test and start-up service — is highlighted in 12-page, 4-color brochure. Covers packaged boilers through 600 hp for heating and processing, steam or hot water. Is ideal study and permanent file material for engineers, architects, and owners of industrial, institutional and commercial buildings. Brochure covers today's high standards in modern boilers, discussions of current design trends, burner design, automatic operation, efficiency ratings and factory tests. *Cleaver-Brooks Company.*

Circle number (68) on reply card.

"Fluidics" Literature

Sixteen-page "Fluidics" Buyers' Guide of interest to companies who handle or process liquids or gases is now available. Bulletin explains Fluidics — the science of fluid processes — as a new Pfaudler Permutit program providing a modern, imaginative approach plus specialized materials and equipment for handling and processing more profitably liquid and gases used by industry. Pertinent applications range from reactions to storage, from water treatment to waste treatment, from design and development to project engineering. Each section is illustrated with application photos and concise engineering data indicating the manner in which Pfaudler will plan, engineer and manufacture facilities for specific unit operations or integrated continuous operations. *Pfaudler Division of Pfaudler Permutit, Inc.*

Circle number (69) on reply card.

Field Erection Brochure

Current field installations are shown in a 4-page field erection brochure which also describes many fabrication processing and engineering services available for production of modern equipment. *Solar Chicago, division of U. S. Industries, Inc.*

Circle number (70) on reply card.

Expansion Joint Literature

Compact, 6-page bulletin on expansion joints contains general information on flanges, liners, covers, temperature ratings and other material of interest to joint users. Photographically and graphically illustrated. *Badger Manufacturing Company.*

Circle number (71) on reply card.

Cryogenerators Folder

Folder titled "Norelco Cryogenerators — For Gas Liquefaction Systems" gives engineering information on 4 models: 3000, 12,000, 30,000, and 170,000 Btu per hr — all at —320 F. Curves are presented showing relationship between refrigeration capacity, condensing temperature and brake horsepower. Text describes operating principle and lists applications which include recovery of liquefied gases, gas purification, air separation, conversion of oxygen and nitrogen plants, gas separations, environmental chambers, cryopumping and high vacuum systems. *Cryogenics Division, North American Philips Company, Inc.*

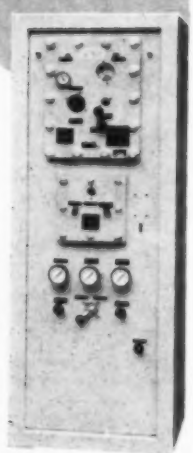
Circle number (72) on reply card.

Industrial Design Brochure

"Profitable Facilities Through Good Financial Design", an attractive illustrated brochure in color, describes design, engineering and construction services of J. F. Pritchard & Company. These services include: economic analysis, process design and evaluation, model construction, complete engineering, procurement, inspection and expediting, field construction, cost control and accounting, and initial operation. *J. F. Pritchard & Company.*

Circle number (73) on reply card.

DETERMINE Moisture CONTENT of JET FUELS OILS GASES with the MEECO UNIVERSAL MODEL W ANALYZER



Full scale on most sensitive range,

to one milligram of water per liter of liquid. To 10 p.p.m. of moisture by volume in gases.

Direct reading scales— no computation necessary.

Includes novel self checking features.

Write for complete information.

Explosionproof Universal Model W. (Other models including portable models for moisture in gas are available.)

MANUFACTURERS ENGINEERING & EQUIPMENT CORP.
Sunset Lane & York Rd. • Hatboro, Pa.
MEECO Instruments

Distillation Bulletin

"High Vacuum Distillation Equipment," a 16-page illustrated bulletin in color, describes the complete family of high-vacuum stills, spanning the range from laboratory investigation through pilot plant operation to commercial production at rates up to 2000 lb of material per hour, now available from the *Rochester Division of Consolidated Electrodynamics Corporation.*

Circle number (74) on reply card.

Corporate Brochure

Two-color, 8-page brochure depicts Houdry's contributions to progress in 3 growth industries. Company's engineering, research and development and manufacturing capabilities are discussed on separate pages. Processes listed include Houdriflow and Houdresid for catalytic cracking, Iso-Plus and Houdriform for catalytic reforming, and dehydrogenation for olefin and diolefin production. *Houdry Process Corporation.*

Circle number (75) on reply card.

Pressure Vessel Brochure

Pressure vessels are the subject of a 4-page brochure just published. Thumbing through the brochure, you will see a great variety of pressure vessels for many different processes. You will also see new fabricating techniques and facilities that are utilized in the production of process equipment. *Solar Chicago, division of U. S. Industries, Inc.*

Circle number (76) on reply card.

Tube Protector Leaflet

Details on new condenser and heat exchange tube protectors that extend usable life of old tubes and greatly increase life of new tubes are given in a recently published bulletin. Protectors are available in 3 plastics — nylon, polyethylene and phenolic resin. They resist corrosive, chemical and fungus attack, are impervious to oils and greases, and will withstand temperatures up to 250 F. *Crane Packing Company.*

Circle number (77) on reply card

PIPELINE Engineer

Engineering and Operating Section

ALLIED CHEMICAL'S HOTLINE ENAMEL SOLVES HOT-SIDE PROBLEMS

Allied Chemical's Hotline Enamel takes high temperature punishment from the hot-side of compressor stations . . . for years! Allied Chemical's Hotline Enamel won't crack at −10°F.—as proved in laboratory tests and on-the-job performance for leading public utility companies.

Allied Chemical's *Job-Matched* Hotline Enamel is derived from coal-tar pitch, thus possessing inherent protective properties against the damaging effects of water, soil chemicals and electrical currents. In addition to these properties, Hotline Enamel is bargain rated both for initial cost and long-run service.

Provides improved protection under all these specific conditions:

1. Hot gas pipelines, on discharge side of compressor stations where line temperature is above 120°F.
2. On pipe-type cables or "oil-o-static lines" which are subject to internal electrical heat from high-voltage surges.
3. Warm, swampy areas or other places where excessive soil stress on pipelines is encountered.
4. Areas where backfill and trenches are rough, rocky or contain foreign objects which normally penetrate softer coatings.
5. Pipelines (such as heated fuel lines) where temperatures are consistently high most of the time, but do not exceed 180°F. or for short-term exposure, 200°F.

A staff of Field Service Experts are at your call to offer you technical assistance that can save you maintenance time and costs.

PLASTICS AND COAL CHEMICALS DIVISION
40 Rector Street, New York 6, N. Y.

Allied Chemical

Barber-Greene Model 774 Wheel Ditcher with new, simple hydraulic controls gives you more ditch per day. Write for new bulletin.

New hydraulic ditcher controls give more ditch under all conditions

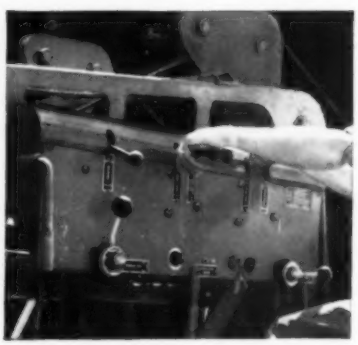
Simple hydraulic controls on the Barber-Greene Model 774 Wheel Ditcher and Model 784 Vertical Boom Ditcher give greatest accuracy, offer a new high in operating ease. The result is more ditch —and more profit—per day.

The entire control panel, with all controls within easy reach, results in less fatigue and greater comfort for the operator. Hydraulic brakes, controlled by convenient foot pedals, give easiest steering and greatly increased accuracy.

Exclusive Hydra-Crowd transmission allows instant selection of fastest crowding speed for every condition from infinite range available. Spoil conveyor speed infinitely variable, independent of wheel or bucket line and crowding speeds. All mechanical shifting in selecting speeds is eliminated. Electrically actuated overload release is set by simply turning a dial.

All these Barber-Greene Ditchers have advanced hydraulic controls:

Cross Country—Model 774 Wheel Ditcher, illustrated above.
City Work—Model 784 Vertical Boom Ditcher, convertible to wheel ditcher.
House Services—Model 705-B Runabout Ditcher, pneumatic tires.
New Mobility—Model 711 Inclined Boom Ditcher, truck-mounted.
Underground Cable—Model 702 Ditcher, Varidraulic transmission.



Operators learn to run these machines quickly and accurately . . . no complicated gear selections and fatiguing manual operations.

58-33-D

Write for literature on the ditcher line of advanced design.

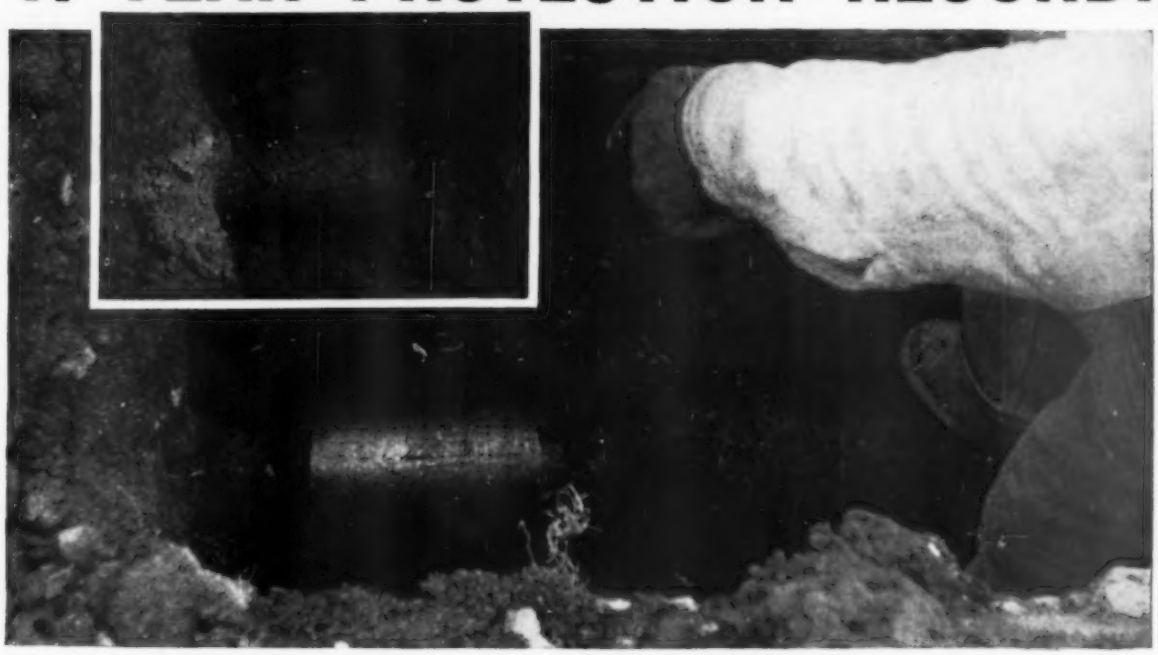
Representatives in Principal Cities of the World

Barber-Greene BG

Main Office and Plant AURORA, ILLINOIS, U. S. A.
Plants in DeKalb, Illinois, Detroit, Canada, England, Brazil, Australia

CONVEYORS . . . LOADERS . . . DITCHERS . . . ASPHALT PAVING EQUIPMENT

17-YEAR PROTECTION RECORD!



Year After Year...More Evidence Proving That TAPECOAT Adds Years of Service Life to Gas Lines Underground or Under Water

Right across the country, TAPECOAT installations prove that you get more for your money when you measure pipe protection with a calendar.

Since this cost-cutting coal tar coating in tape form was first introduced in 1941, it has demonstrated its ability to withstand severe conditions underground or under water. TAPECOATED lines dug up after 17 years of service show no signs of deterioration on the pipe.

Typical is the experience of a utility in a coastal area. For a thorough trial, this company applied TAPECOAT in areas where severe corrosive conditions were known to exist. The lines were dug up this year and, after years of service under severe conditions such as brackish waters and corrosive soil, the pipe showed no signs of corrosion, proving the quality of TAPECOAT protection.

In terms of preventive maintenance and replacement costs, performances like this emphasize the most important consideration in buying protection. Remember, TAPECOAT is a hot-applied coal tar coating in tape form—designed for lasting protection on pipe, pipe joints, service connections, mechanical couplings, fittings, insulated lines, tanks, tie rods, and other steel surfaces vulnerable to corrosion.

TAPECOAT comes in rolls of various widths and is available in asphalt. Where primer is desired, specify TC Primecoat, the compatible coal tar primer.

A TAPECOAT sales and service engineer is always available to help you on any corrosion problem. Write for complete details today!

GEM MEMBER

TAPECOAT®

The TAPECOAT *Company*

ORIGINATORS OF COAL TAR COATING IN TAPE FORM

1533 Lyons Street, Evanston, Illinois

REPRESENTATIVES IN PRINCIPAL CITIES

Manufactured and Distributed in Canada by The Tapecoat Company of Canada, Ltd., 25 Haas Road, Rexdale, Ontario.

IT TAKES LESS THAN 500 MANHOURS TO INSTALL A **FIN-PAK®**

Dual Fin-Pak heat exchangers at El Paso Natural Gas Company's compressor station at Caprock, New Mexico. The two 5,000-hp gas turbines at the Caprock station pump an average of 12,000 CFM, 24 hours a day.

Fin-Pak's prefabricated design, light weight and compactness cut installation time and labor costs to a minimum. On a typical 5,000-hp gas turbine cycle, for example, fewer than 500 manhours are required for *complete* installation of a Fin-Pak.

And installation economies are just the beginning. In operation, a Fin-Pak can cut your fuel bill by as much as 32%*, because it recovers up to 80% of the heat from the turbine exhaust and returns it to the combustion air.

And maintenance is a cinch with the Fin-Pak. It has short, straight-through passages. Occasional cleaning with compressed air is *all* the maintenance a Fin-Pak needs. **One last thought:** a gas turbine station requires about 80% *less* plant maintenance personnel than a station of equal capacity operating diesels, steam turbines or gas engines. For complete details, call or write Air Preheater.

*A Fin-Pak with a designed efficiency of 75% in a gas turbine cycle at 6 to 1 pressure ratio and a turbine inlet temperature of 1500°F.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

Why explode **dynamite** inside Armco Line Pipe?

This dynamite test was conducted on Armco Line Pipe to determine how the welded seam would hold up under severe shock. Enough dynamite was exploded inside sections of 6-inch, .219-inch wall Armco Line Pipe to almost sever the pipe. Yet the pipe wall and the seams did not open outside the immediate explosion area. This shows that the welded seam resists shock at least as well as the pipe wall. In your pipe line, this means no weak spots, adequate shock resistance to withstand pressure surges and external impacts.

Get the complete story on the advantages of Armco Line Pipe. Just write us for the catalog, "Armco Welded Steel Pipe for the Oil and Gas Industries."

Armco Drainage & Metal Products, Inc., 4519 Curtis Street, Middletown, Ohio, or 201 KOME Building, Tulsa, Oklahoma.

ARMCO DRAINAGE & METAL PRODUCTS

Subsidiary of ARMCO STEEL CORPORATION

OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company
The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

PARTNERS IN PIPELINE PROTECTION

Johns-Manville
BLUE FLAG®
Fiber Glass Wrap

AND

Johns-Manville
TRANSHIELD®
Asbestos Felt

—your assurance of maximum protection

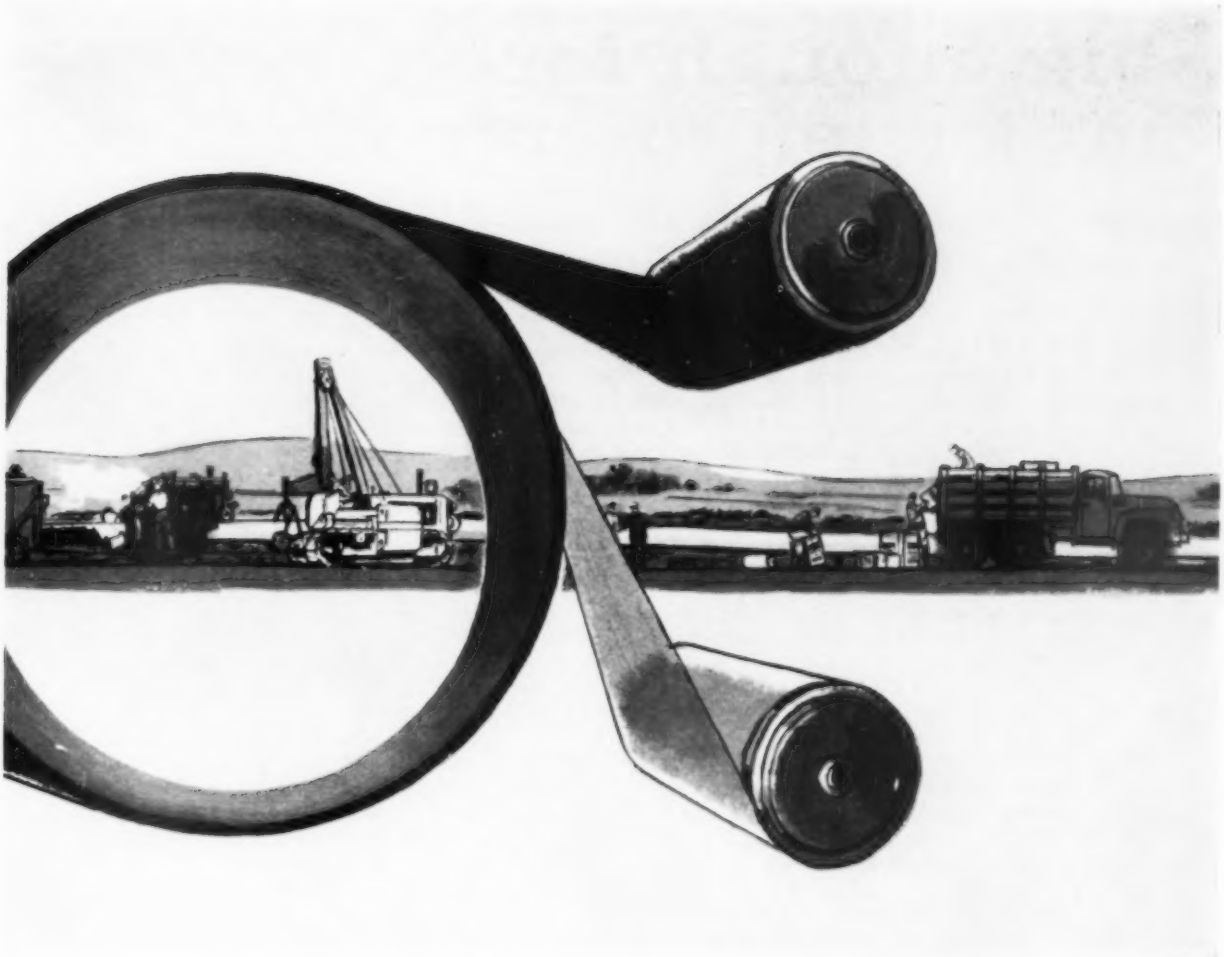
J-M Blue Flag Wrap is made of specially formulated, chemically resistant glass fibers which are parallel reinforced with continuous strands of fiber glass yarn for high-speed application.

1 J-M Blue Flag Wrap—for enamel reinforcement

Johns-Manville Blue Flag Wrap is a uniformly porous fiber glass wrap. It lets enamel bleed through quickly . . . actually becomes an integral part of the over-all pipe coating. Like steel reinforcement rods in concrete, Blue Flag reinforces the pipe enamel giving it extra strength, hence extra working life. Because it is made of inert, inorganic fiber glass, this wrap cannot rot, decay, or absorb moisture.

With L.O.F. Glass Fibers Company joining the J-M family, buyers of pipeline wraps and tapes are now additionally served . . . by an enlarged staff of Johns-Manville sales and technical personnel operating out of 56 sales offices . . . by expanded distribution facilities . . . by the addition of 7 strategically located plants . . . by expanded research and product development laboratories. For further information, write to J-M, Box 158, N.Y. 16, N. Y. In Canada, Port Credit, Ont.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



and service life for pipelines

J-M Transhield Felts, asbestos reinforced with parallel glass fibers, come in 2 types for field or mill wrapping: #15 Transhield (heavyweight); #8 Transhield (standard). #15 plain Asbestos Felt also available.

2 J-M Transhield—for a tough outer shell

Apply an outer wrap of this inert, inorganic asbestos felt—and give your pipeline investment *complete* long-life protection. Asbestos, the magic mineral, comes from the ground . . . is always at home in the ground . . . won't rot or decay. In J-M Transhield these asbestos fibers are impregnated with a coal tar or asphalt saturant to form, literally, a flexible covering of stone, providing a strong, highly durable outer protective shell.

JOHNS-MANVILLE

JOHNS MANVILLE JM PRODUCTS

ALLIS-CHALMERS HD-16 SIDE BOOM TRACTOR...

big enough for major league pipelining–

but it can help you fight the profit squeeze on tough, small-capacity jobs, too

The HD-16 side boom tractor—150 hp, 39 tons lifting capacity—is building its reputation as a production booster on some of the biggest pipelining jobs in the business. Yet its broad working range makes this machine a profitable investment for many of the tough pipe-handling chores on 12-inch and even smaller. The HD-16 has more pipeliner-approved features than any other side boom tractor in its class—including torque converter drive and internal-expanding, enclosed side boom brakes.

Next time you're lining up equipment for a pipeline project, here's a good way to find out what HD-16 side boom tractors can do. *Be your own tractor salesman!* Tell your Allis-Chalmers dealer you want to watch the HD-16 in action. He'll arrange to put you out on a working spread where you can see and hear the story firsthand.

Talk to the spread boss. Talk to the foremen and the tractor-side boom operators. Talk to the maintenance crew. Wherever you talk HD-16, comments like the following are typical . . .

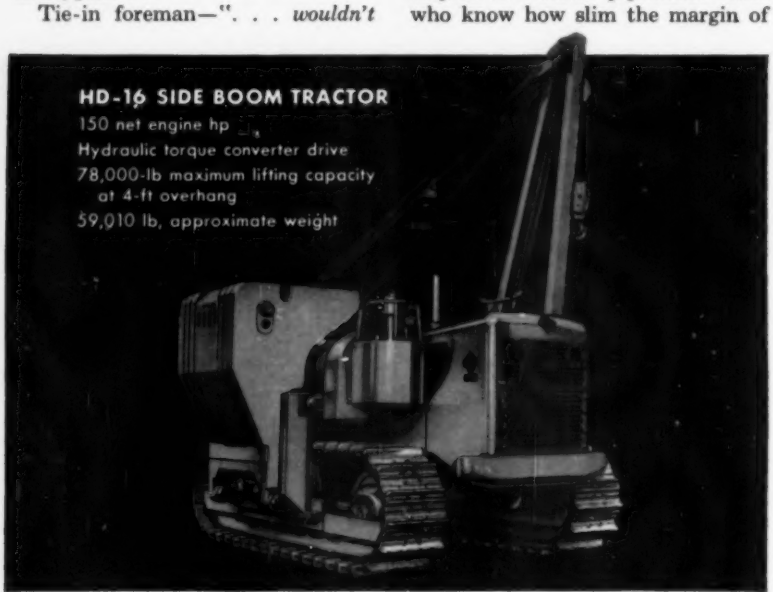
Tie-in foreman—". . . *wouldn't want anything else for this kind of operation.*"

Superintendent—". . . *a perfectly balanced machine.*"

Master mechanic—". . . *best in the business for easy maintenance.*"

Word gets around

Maybe you'll find a spread that's having tough going—bulling its way through the kind of nightmare pipelining that separates the men from the boys. That's where you'll get a chance to see the HD-16 demonstrate performance that has earned the respect of veteran pipeliners—men who know how slim the margin of profit can get when a spread bogs down. No wonder the word gets around!


HD-16 SIDE BOOM TRACTOR
150 net engine hp
Hydraulic torque converter drive
78,000-lb maximum lifting capacity at 4-ft overhang
59,010 lb, approximate weight

Extra-tough track cuts costs

Allis-Chalmers track is famous in the industry as the toughest ever made. Special hardening of sidebars, pins and shoes gives you a track that consistently outlasts any other make—reduces maintenance and replacement costs and keeps your tractor producing at a profit.

The HD-16's PERMA-SAFE truck wheels, idlers and support rollers are permanently lubricated at time of assembly, *need no further greasing*—regardless of weather or operating conditions.

The Allis-Chalmers Positive Seal, tapered roller bearing design has been proved beyond doubt in *millions of hours* of actual operation in the field during the past 20 years.

Long, 7-roller tracks and 24-in. shoes distribute tractor and load weight, provide generous ground-contact area for sure-footed flotation and balance on the mushiest right-of-way. High, wide clearance from front to rear eliminates power-wasting undercarriage drag.

Smoothest power you can buy

Hydraulic Torque Converter Drive—pioneered by Allis-Chalmers in crawler tractors in 1940, 14 years ahead of any other manufacturer—

...move ahead with

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

HD-16 side boom tractors on a fast-moving spread build a 24-in. pipeline through 100 miles of mountain forests in Pennsylvania. The torque converter tractors' smooth power and stability help keep the swift pace in close maneuvers like this.

is standard equipment in the HD-16 side boom tractor. Whether you call for delicate, inch-by-inch cradling or driving full blast for the horizon, the torque converter automatically matches tractor speed to the load, cushions the power train and side boom from shocks and strains, eases the tractor in and out of mud holes without digging in. With no shifting needed, the operator gives full attention to signals and boom controls, lets the tractor take care of the footwork.

Allis-Chalmers side boom controls—sure, fast, safe

Side boom controls on the HD-16 operate easily in needle bearings, and they're located in comfortable reach for the operator. Internal-expanding brakes on load and boom line drums are completely enclosed for protection from dirt and moisture. Hydraulically controlled counterweights are hinged on the heavy-duty rigid truck frame, provide high ground clearance when fully extended to handle capacity boom loads.

Pipe-handling speed and efficiency in the HD-16 is combined with proved Allis-Chalmers safety features, including cable guards; detent-locking winch controls; drop-proof counterweight linkage; jaw-type winch clutches and precision-fitted, enclosed brakes. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS...power for a growing world

GONE . . . BUT NOT FORGOTTEN!

That decision you made a year ago on pipeline coatings is irrevocable now. It's in the ditch and only time will tell—time and the maintenance records.

Time *has* told on a lot of pipelines. And the story is that there's no more proven enamel than Bitumastic *coal-tar* enamel. Over thirty years of use in pipelining have documented coal tar's superior moisture resistance and electrical insulating properties underground.

Coating cost is but a minute fraction of total pipeline investment: can you afford to gamble your pipeline investment on unproved products? Koppers Company, Inc., Tar Products Division, Pittsburgh 19, Pennsylvania. *In Canada:* Koppers Products, Ltd., Toronto.

District Offices: Chicago, New York, Boston, Los Angeles, Pittsburgh and Woodward (Birmingham) Alabama.

KOPPERS

BITUMASTIC
REG. U. S. PAT. OFF.
COATINGS AND ENAMELS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

PROTECTION
IS OUR FULL TIME JOB

To get this complete, dependable protection you need but to specify Nicolet Asbestos Pipe Line Felts. Nicolet Saturated Felts come in 2 weights:

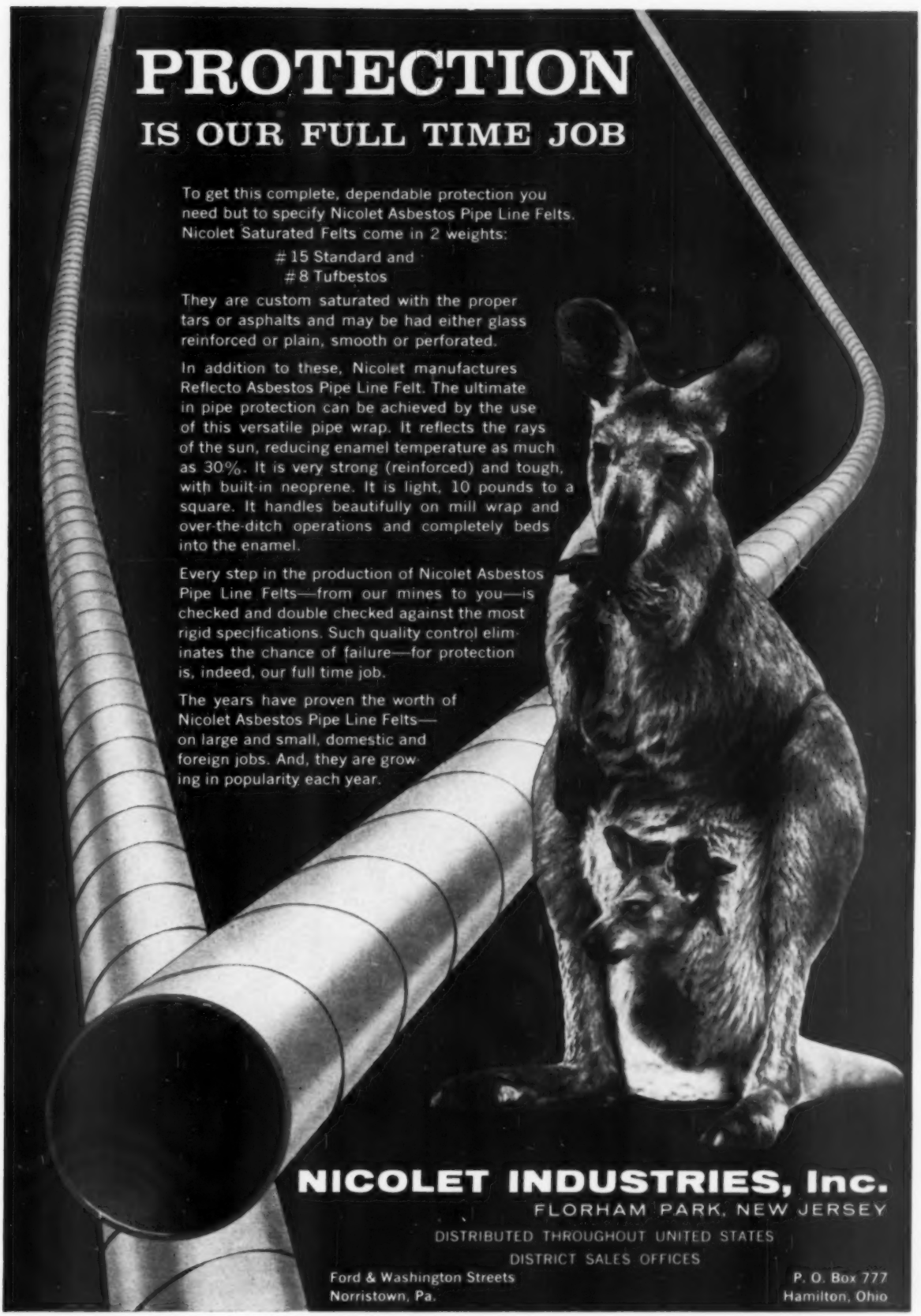
#15 Standard and
#8 Tufbestos

They are custom saturated with the proper tars or asphalts and may be had either glass reinforced or plain, smooth or perforated.

In addition to these, Nicolet manufactures Reflecto Asbestos Pipe Line Felt. The ultimate in pipe protection can be achieved by the use of this versatile pipe wrap. It reflects the rays of the sun, reducing enamel temperature as much as 30%. It is very strong (reinforced) and tough, with built-in neoprene. It is light, 10 pounds to a square. It handles beautifully on mill wrap and over-the-ditch operations and completely beds into the enamel.

Every step in the production of Nicolet Asbestos Pipe Line Felts—from our mines to you—is checked and double checked against the most rigid specifications. Such quality control eliminates the chance of failure—for protection is, indeed, our full time job.

The years have proven the worth of Nicolet Asbestos Pipe Line Felts—on large and small, domestic and foreign jobs. And, they are growing in popularity each year.



NICOLET INDUSTRIES, Inc.
FLORHAM PARK, NEW JERSEY
DISTRIBUTED THROUGHOUT UNITED STATES
DISTRICT SALES OFFICES
Ford & Washington Streets
Norristown, Pa.
P. O. Box 777
Hamilton, Ohio

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

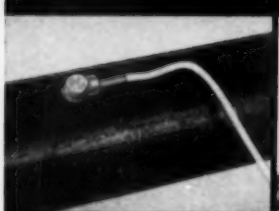
for cathodic protection...

BURNDY thermOweld®

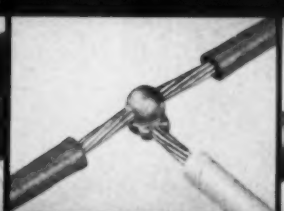
FIRES EVERY TIME!

THE POWDER MAKES THE DIFFERENCE!

THERMOWELD's cohesive starting powder can't mix with the welding charge. This assures full-strength ignition that fires the welding charge every time. Just pour the welding charge from the moisture-tight cartridge into the Thermowelder and tap to release special starting powder. Ignite for perfect, permanent electrical weld connections—anode and header leads, jumper bonds, and other cathodic protection connections.



Anode Leads
Sounder, surer welds



Header Leads
Higher conductivity connections

Jumper Bonds
Easier strap or cable bonds

For complete details on softer slag, sure-fire **THERMOWELD** connections for cathodic protection, call your Burndy representative or write: **BURNDY**, Norwalk, Connect.

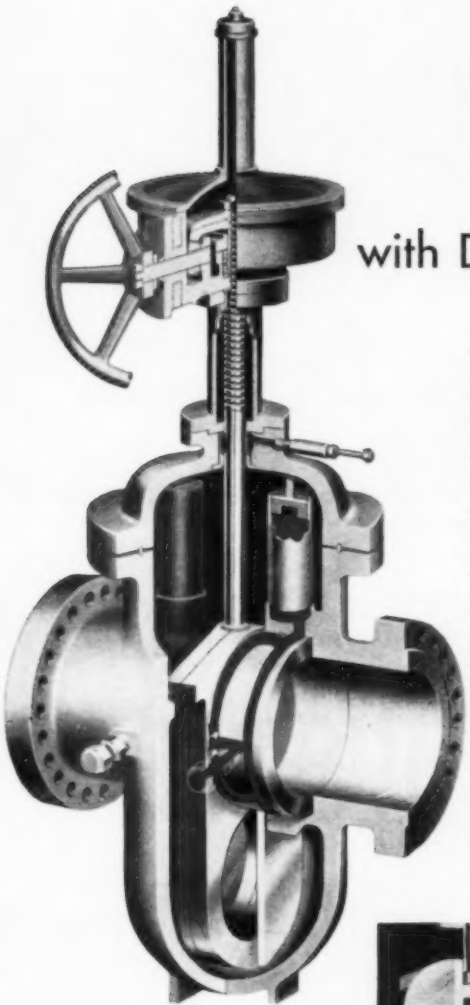
BURNDY

59-10

Norwalk, Connect. **In Europe: Antwerp, Belgium** **Toronto, Canada**

NEW ADVANTAGES "GO ON THE LINE"

with DARLING-McEVOY Conduit Valves



Above: *Cutaway showing heavy, self-aligning gate and parallel seat assembly, with one of the two sealing systems indicated.*

Compare these features with *any* other pipe line gate valve:

1. **EVERY CLOSURE LEAK-PROOF.** No forcing. Positive automatic self-sealing under line pressure between seats and gate and between seats and body by means of sealing compound.

2. **NON-DIRECTIONAL.** Flow may be in either direction. Sealant cylinders operate independently.

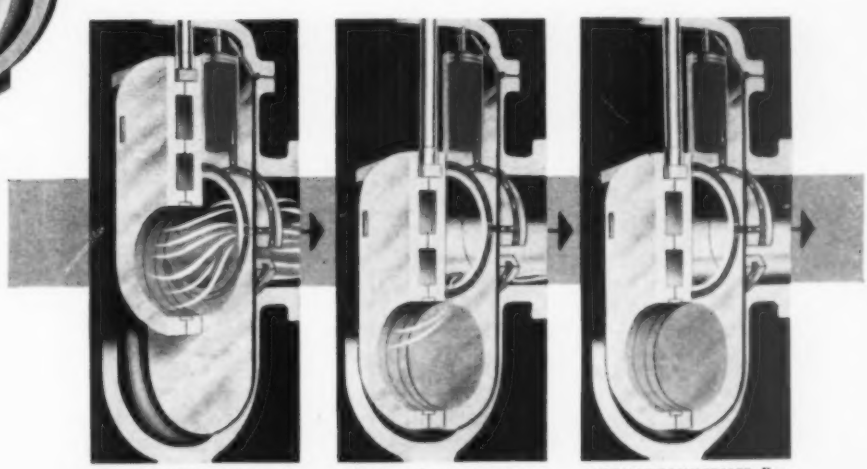
3. **TWIN SEALANT RESERVOIRS.** One for each port. Sealant feeds automatically to downstream side only.

4. **NEGLIGIBLE SERVICING.** Leak-proof closure requires very little sealant. Reservoir capacity ample for 50 to 80 operations dependent on differential pressures.

5. **SMOOTH, FULL FLOW.** No impediments. No turbulence. No pockets to collect sediment.

6. **EXCEPTIONAL PERFORMANCE AND LIFE.** Self-aligning gates. No wedging. Non-distorting seats, protected when valve is open or closed.

Darling-McEvoy conduit valves, made in 4" and larger sizes, are fully field proved and are now operating continuously on various major lines. For complete information on the self-sealing feature and many other advantages of this unique valve, ask for Bulletin 5402.



Right: *Diagrams of closure action on downstream side of gate.*

APPROACHING CLOSURE ... *No loss of sealant as sealing groove in seat is disconnected from reservoir until gate is fully closed.*

CLOSED ... *Jumper in gate now permits differential pressure to feed sealant into seat groove to check any remaining flow.*

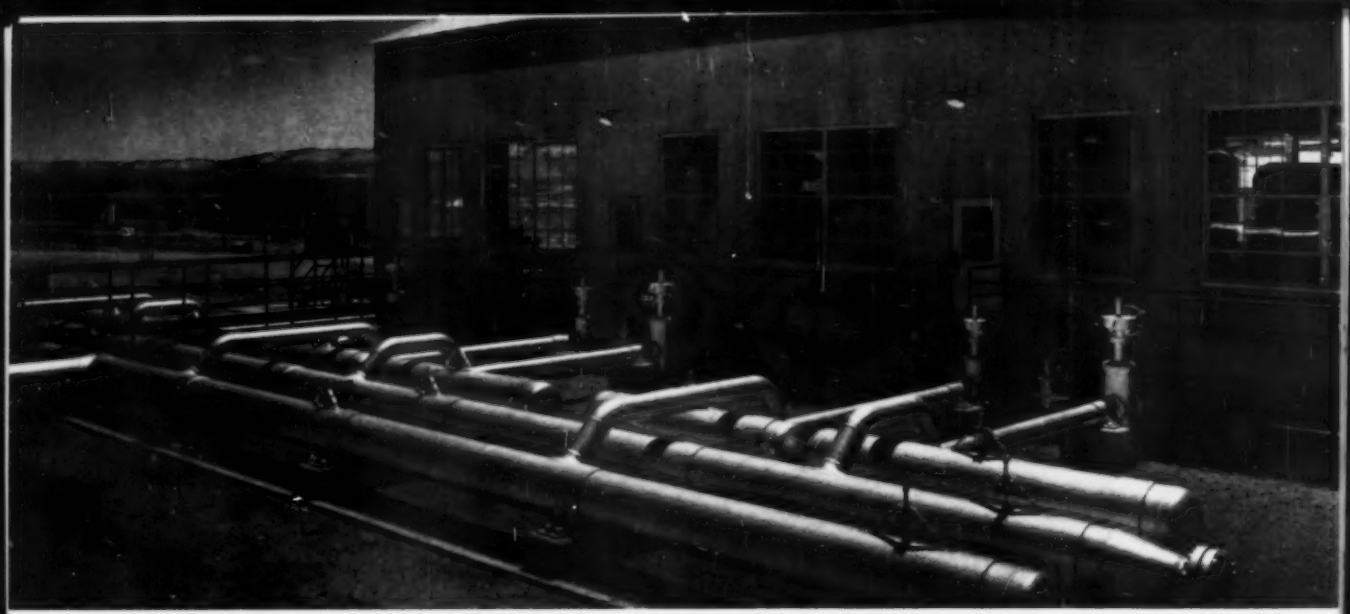
AUTOMATICALLY SEALED. *Pressures again in balance. Tightness established. No additional sealant used until again needed.*

DARLING VALVES

DARLING VALVE & MANUFACTURING COMPANY

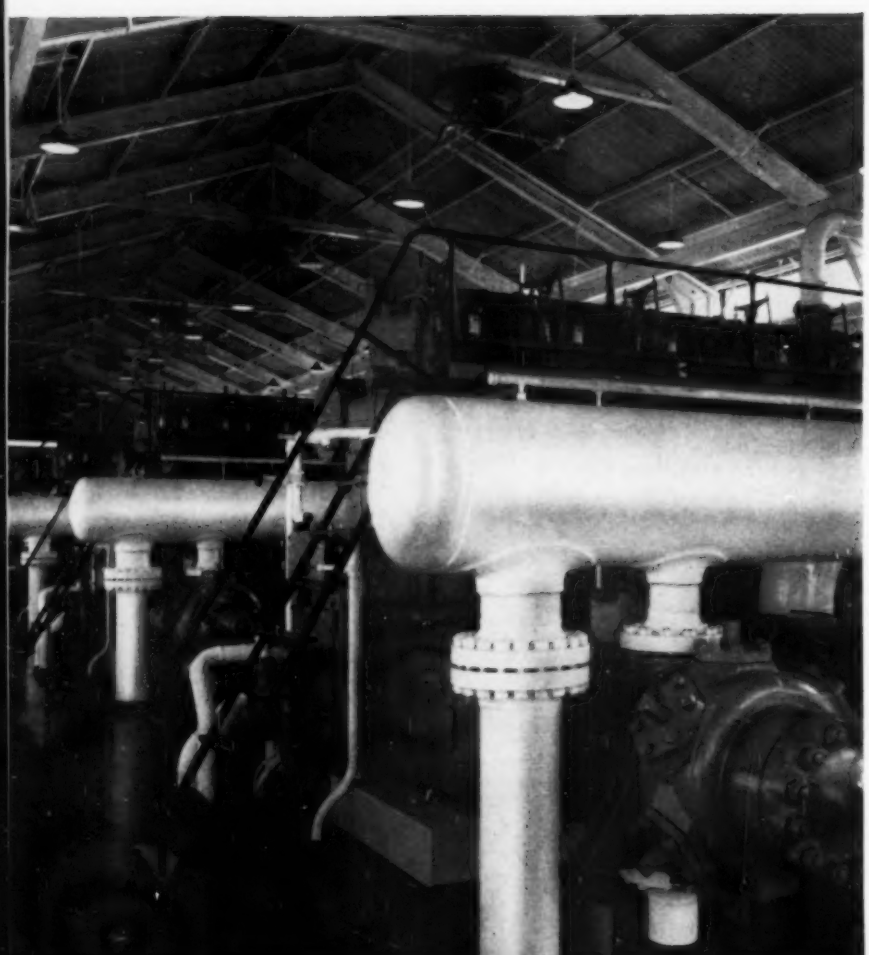
Williamsport 2, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario



Station No. 7, at Kemmerer, Wyoming, rated at 5,060 hp, is 7,325 ft above sea level. Mayari R suction and discharge headers and pulsation dampeners are in the foreground.

Bethlehem Compressor Station Stations on the



The Pacific Northwest Pipeline

ranks with the most challenging of all pipeline projects—in total length, in size of pipe, in difficulty of the terrain, in severity of weather encountered during construction, and in the speed with which the job was completed. The remarkable success of the planners and constructors in overcoming obstacles is well-known to all pipeliners.

The 1,487-mile main line (26-in. OD) is unusual in that it is supplied at both ends, as well as at various intermediate points. Its southern terminus is at Ignacio, Colorado, in the San Juan Basin. Its northern terminus is at Sumas, on the Canadian border, where it ties in with a line from the Peace river fields. Gas is also delivered from the Piceance Creek and Rangely fields in Colorado, and Wyoming's Big Piney. Laterals bring total length of the line to well over 2,500 miles.

Fish Engineering Corporation handled all of the design, engineering, and station layout work, while Fish Northwest Constructors, Inc., were responsible for construction of the stations as direct agents for the owner, Pacific Northwest Pipeline Corporation.

This is Compressor Station No. 1 at Ignacio, Colorado, with 22-in. OD Mayari R suction and discharge bottles in evidence. Largest station on the system, its seven 2,000-hp units discharge gas to the line at 800 psi.

IN NEW JERSEY—36-in. OD Bethlehem line pipe being installed for a major transmission line. Numerous pipeline companies are already considering the economies of 42-in. pipe now available from Bethlehem.

Pipe Was Used at All Thirteen Pacific Northwest Pipeline

THERE are thirteen compressor stations, totalling 82,780 horsepower, along the 1,487-mile main line of the Pacific Northwest Pipeline. For these vital installations the Fish Engineering Corporation specified Bethlehem's Mayari R compressor station pipe—*exclusively*. It was used in 22-in. and 26-in. sizes for suction and discharge lines, headers, and bottles, and for pulsation dampeners.

Why? Because Mayari R high-strength, low-alloy steel is extremely strong (yield point, 50,000 psi min) and ductile (22 pct min elongation in 2 in.). It's highly recommended for applications subject to high pressures, pulsation, and vibration. And it's readily weldable, too.

Mayari R pipe is available in diameters from 18 in. up. It does not require heat treatment. Bethlehem supplies Mayari R plate to fabricators of elbows, tees, flanges, and other fittings.

Line Pipe to 42 in. OD. At Steelton, Pa., we produce API pipe, electric-fusion-welded and hydraulically expanded, from 18-in. to 42-in. OD, with walls to ¾ in. in all diameters. Electric resistance-weld pipe from 5 5/16 in. to 16 in. OD, and continuous buttweld pipe from ⅛-in. to 4-in. nominal, are produced to standard API line pipe specifications on our Sparrows Point, Md., pipe mills.

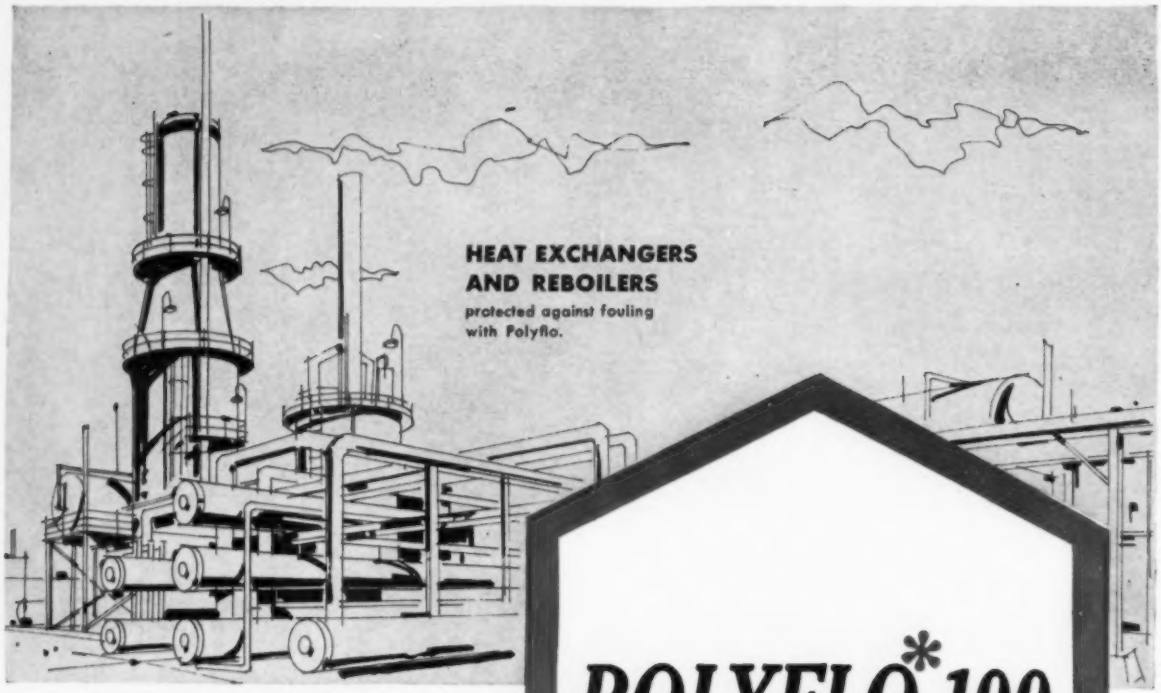
For more information about Bethlehem line and compressor station pipe, please contact the Bethlehem sales office nearest you. Ask for a copy of our new publication, Booklet 519, containing useful design tables concerning sizes 18 in. to 42 in., inclusive.

IN CALIFORNIA—Lines of Beth-Co-Weld pipe carry product from 24 wells to an automatic trap farm. Many miles of this reliable line pipe are used each year by the oil and gas industries.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL



HEAT EXCHANGERS AND REBOILERS
protected against fouling with Polyflo.

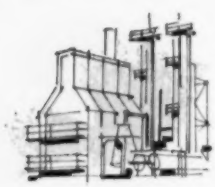
NOW... POLYFLO* 100

1 Multi-purpose Inhibitor-dispersant solves 5 pressing problems

A highly convenient all-around inhibitor-dispersant, UOP Polyflo 100 is also an effective stabilizer against thermal changes, color deterioration, sludge and deposit formation.

An effective dispersant for distillate, residual and crude oils, Polyflo 100 also eliminates fouling and sludge formation in heat exchangers and storage tanks.

Polyflo is but one of a variety of inhibitors and additives developed by UOP for petroleum refiners. Write our Products Department for detailed information on these products. Ask also about the services of our staff of treating field engineers, who will gladly work with you to solve specific problems.



No. 2 HEATING OIL
stabilized against color deterioration and sludge deposition.

DIESEL FUELS
also effectively stabilized with Polyflo.

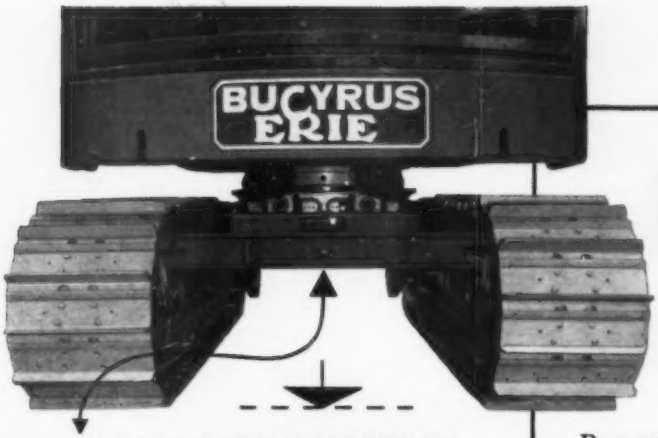
OIL STORAGE TANKS
for distillate, residual and crude oils—kept free of tank bottoms.

JET FUELS
attain thermal stability with Polyflo.

* TRADEMARK

UNIVERSAL OIL PRODUCTS COMPANY
30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U.S.A.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



21¼ BIG INCHES OF CLEARANCE

Hi-Walkers move right over rock and dirt that foul up many a rig because they have more clearance than any other hoe this size (¾-yd).

Hi-WALKERS

...Rigs with a Record!

Bucyrus-Erie Hi-Walkers have the clearance and the design features that keep them moving, give a big lift to spread schedules, regardless of the tough going.

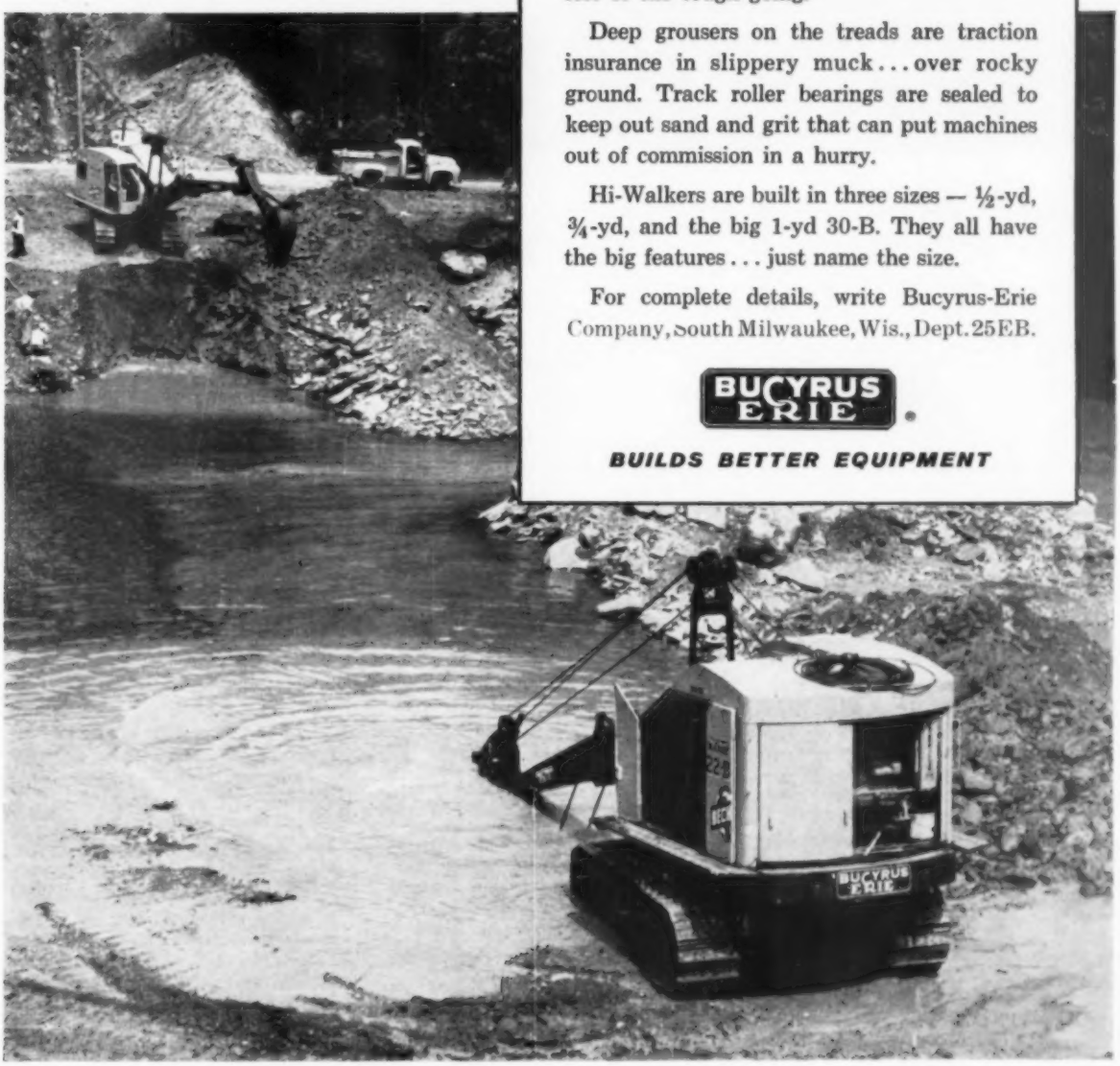
Deep grousers on the treads are traction insurance in slippery muck... over rocky ground. Track roller bearings are sealed to keep out sand and grit that can put machines out of commission in a hurry.

Hi-Walkers are built in three sizes — ½-yd, ¾-yd, and the big 1-yd 30-B. They all have the big features... just name the size.

For complete details, write Bucyrus-Erie Company, South Milwaukee, Wis., Dept. 25EB.

BUCYRUS ERIE

BUILDS BETTER EQUIPMENT



Even your dome light draws more current than MOTRAC 2-way radio!

Motorola ends costly power drain problems and idling expense with the first fully transistorized receiver and power supply

What makes Motorola MOTRAC radio the most economical and reliable 2-way radio unit in the annals of mobile communications? Not just one or two new features, but a score of revolutionary design advancements that bring you the very finest set ever engineered.

1. On standby—the MOTRAC receiver draws only a trickle of current—actually 80% less than conventional units—with an occasional increase to maintain crystals at proper temperature for precise on-frequency operation (even your dome light draws more current than MOTRAC radio). Yet, this radio is always poised for instant reception, thanks to its fully transistorized receiver. Result: no life-shortening battery drain . . . no more costly, unnecessary engine idling.

2. MOTRAC radio eliminates the most common maintenance problems: vibrators in the power supply and tubes in the receiver. All are replaced by stabilized long-life transistors.

3. Up to 40°F cooler operation means less aging and strain on components. Reason: no more receiver tube filaments; a more efficient power supply; a battery saver switch to cut off transmitter filaments; and two separate heat sinks—one for power supply, another for transmitter output tubes.

4. The MOTRAC receiver operates directly from the 12-volt battery; its low voltage operation results in less electrical strain on components, assures long life.

5. Traditional Motorola engineering and production excellence are evident throughout MOTRAC radio. Transistors undergo three separate checks, including a week of stabilization at 185°F. Only industrial-type tubes, especially suitable for the rigors of mobile operation, are used in the transmitter.

6. Patient production testing continues under stringent quality control procedures. First, each module is tested. Then each chassis is independently checked. Next, each radio is tested as a composite whole. Finally, the entire radio and associated accessories are checked out as a complete operating system.

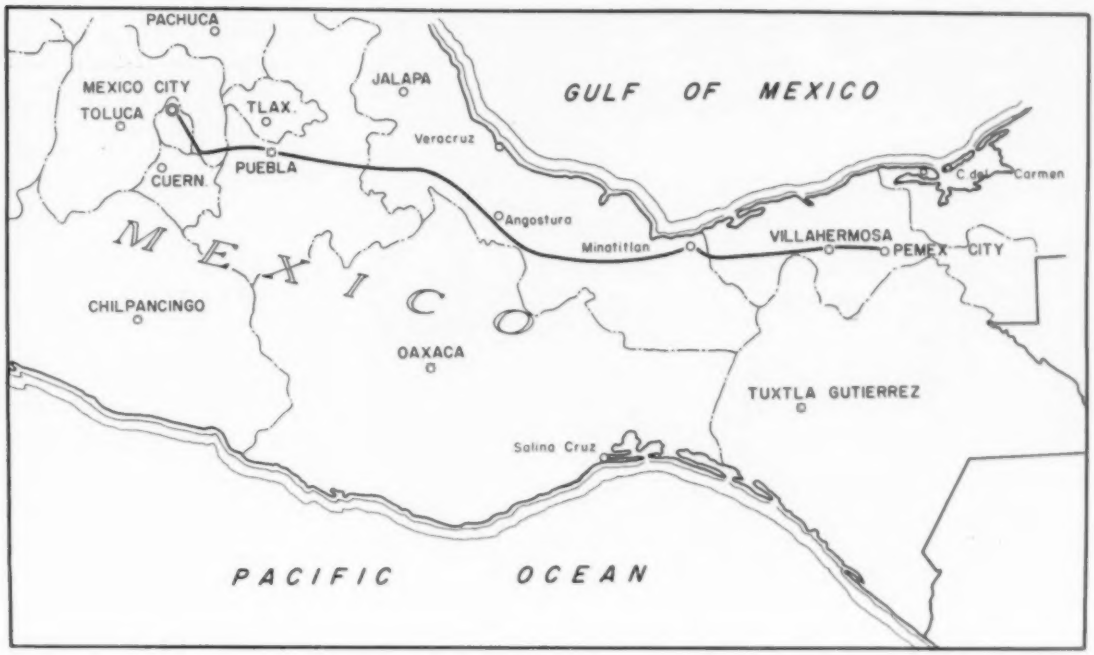
7. MOTRAC radio is conservatively designed. The receiver has *even higher* reserve gain than conventional Motorola units to assure *peak performance* for many years. Also, power supply transistors are operated under an exceptionally high safety factor to assure extended service life.

8. Completely independent receiver and transmitter chassis, with no power supply in common, assure reliable reception regardless of transmitter performance.

9. MOTRAC radio offers you 2½ to 3 times higher audio output than conventional sets.

10. MOTRAC radio is designed for split-channel operation. *Both* receiver and transmitter meet critical split-channel stability frequency requirements.

Experienced users have been field testing MOTRAC radios for many months. The results are in—and they're excellent. We'd like to tell you *all* about them. Write, wire or call: Motorola Communications & Electronics, Inc., A Subsidiary of Motorola, Inc., 4501 West Augusta Blvd., Chicago 51, Ill., SP 2-6500. MOTRAC is a Motorola, Inc. trademark.



Route of the gas pipeline from Pemex City to Mexico City.

Mexican Pipeliners Fight Swamps, Rivers, Mountains

From Pemex City in water-logged Tabasco to Mexico City, Petroleos Mexicanos is constructing its longest and most difficult pipeline

Mary Saint Albans

FROM WATER-LOGGED TABASCO in isolated southern Mexico to 7500 ft high Mexico City, Petroleos Mexicanos is constructing its longest and most difficult pipeline. This 500-mile 24-in. industrial gas line fords hundreds of kilometers of swamps, lagoons, and rivers, snakes through 90 percent rock, bucks up to 40 percent grade, climbs 9000 ft above sea level.

By the middle of 1960, 220,000,000 cu ft of gas a day from Pemex City's new absorption plant will be divided between the Valley of Mexico's swift expanding industrial section and towns along the route. Two compressor stations to be built later will increase the flow considerably.

Seven hundred and ninety kilometers (491 miles) of 24-in. OD, API Grade X-52, 0.344-in. wall thickness, pipe is used on the main trunk line. Dual 12-in. lines are laid 50 meters (164 ft) apart in rivers and lagoons.

Rivers and lagoons! And swamps! That's the big hurdle! With the Tabasco stretches having the most water to cross.

CONSTRUCTION

FEATURE

The state is low and flat and extremely rainy. The third heaviest rainfall anywhere on the globe hits just 20 miles or so from the pipeline right-of-way. Moreover the seventh largest river system in volume of water on the globe, the Grijalva-Usumacinta, covers the state in a mad whirl of main currents and tributaries. Add nine months of constant rain and what have you got?

Water, water everywhere riddled by strips of higher flatish dry land or areas of tropical forest. Even the forests at times stand knee-deep in water. No wonder country dwellers take to their thatched attics much of the year and use cayucos or canoes for transportation.

To worsen the situation every half decade or so comes a rip-roaring flood that may rise, even in towns, 2 or 3

State of Tabasco, where line originates, is covered with rivers, swamps, lagoons.

ft above sea level. Engineers admit it would take several big dams and 1 billion pesos or more to effectively dry up Tabasco.

True, drainage projects already have relieved the situation in the rich Chontalpa zone, and certainly they hastened construction of the Tabasco section of the Gulf Circuit highway. This highway was routed south from the state capital through oil and gas regions. But after six months of frustration the Federal Road Department called off the contractors, veered the highway west from Villahermosa to the port of Frontera and along the coast south. This left the oil and gas regions still isolated, still depending on air and water transportation to the outside world.

From Villahermosa to Ciudad Pemex, as noted before, there's no road — and a lot of water. From Villahermosa north to Minatitlan the pipeline parallels the brand new paved highway 100 meters (328 ft) inland, but there is still a lot of water.

Grijalva-Usumacinta River, seventh largest on globe, here cuts through Villahermosa, capital of the State of Tabasco. Surrounding country is swampland.

Four Contractors on ROW

Four contractors were given the job of building the 15-meter (49.2 ft) right-of-way as far as Minatitlan: Ing. Morton Arocha, CUPSA, Compañía Omega, and Ing. Ruben Flores.

An old hand at constructing roads and oil well locations in Tabasco, and with his 57 kilometers (35.4 miles) bordering the highway, nevertheless Ing. Flores found the going pretty tough. Three-fourths of the stretch was accomplished with machines, tractors, shovels, motorgraders, rollers. He earthfilled 2 or 3 meters (approximately 6.5 to 10 ft) high as is imperative in that region. Sometimes, however, the dumped earth did not stay put but kept disappearing, and ahead the surface bulged. All one could do was add more and more loads of dirt. By attacking the roots first, cutting down ceiba trees was easy. One tractor could fell a 2 meter (6.5 ft) wide tree. When down, however, four tractors were needed to push it out of the way.

Clearing in the 15 kilometers (9.3 miles) of deep swamp was another story. Here no machines could enter. Men waist-deep in water cut down trees with motor saws, and, after they had toppled, sawed them into sections for moving. Dumping on the edge of the morass, trucks gradually built up a base on which to advance.

About 100 kilometers (62 miles) of this pipeline is without benefit of right-of-way. Ciudad Pemex is on high ground, but trouble starts almost at the edge of the absorption plant and town. There is a lagoon with an island in its center, seven lagoons in the nearby Sarlat region, more lagoons near Villahermosa. In fact, morasses and lagoons never let up until one reaches Tierra Blanca in Veracruz, 475 kilometers (295 miles) north from the starting point.

The morasses with a modicum of earth within are handled by laying a corduroy road over which a tractor and winch can pass to the other side in order to pull the pipe. These roads, made up of cross chunks of logs, are called marimbas after the pre-Cortez musical wood-tiered instruments still in high favor in today's fiestas.

Making the River Crossings

Heavily concreted pipe is used not only in the actual river, but for many meters on either side.

Water crossings are constructed much as in the United States, except that small 200-liter (53-gal) pontoons are used instead of fewer large pontoons.

Five wide rivers and uncounted streams impede the way in Tabasco. First comes the historic Grijalva, fol-

lowed by the Rompido de Semaria, the Mexcalapa, the Tonolapan, the Tonalá. Luckily the first three, which lie in the Chontalpa zone, are provided with defense walls, so flood danger is lessened.

The Tonalá, dividing the states of Tabasco and Veracruz, is not far from the former Olmeca ruins in La Venta, from which recently were trucked hundreds of tons of giant heads and the like to a park in Villahermosa.

After Tonalá comes Coatzacoalcos on the exotic Isthmus of Tehuantepec. The crossing is 11 kilometers (6.8 miles) east from Minatitlan. Branch lines lead to that city and to the sulfur installations, which use 32,000 cu ft of gas a day.

In Tabasco the swamps are the big headache; in Veracruz its the rivers. The line has to cross the San Juan, the Tesechoacan, and the Arroyo Obispo, all about 300 meters (984 ft) wide in the dry months. But in the rainy season they expand to 16 kilometers (10 miles) or more. As with Tabasco rivers, the concreted pipe, which must be laid in the dry season, is extended 50 meters (164 ft) on each side. For the remaining 8 kilometers (5 miles) or so, on dry land, which will be flooded a part of the year, river clamps are used.

The Papaloapan does not overflow any more, defense walls 2 kilometers (1¼ miles) apart have gradually coaxed the former 300-meter (984 ft) wide rapid current to fill the entire space and calm down a bit.

Tabasco is practically devoid of gravel. The concrete plant located at Minatitlan ships concrete to the river and swamp sites by road as far as Villahermosa, by river to the region near the absorption plant, by road to south Veracruz.

As if water were not enough, looms too the constant danger of snakes.

Management insists that snake serum always be within a few feet of the workers. Inspecting engineers carry it in their jeeps, take it along when they walk the right-of-way. So far there's been no fatalities but the superintendent admitted he'd be much happier if the men would wear Spanish armor suits.

In Tierra Blanca swamps and snakes end. And soon, too, the humid heat, which can reach 110 F, is no more. For about 100 kilometers (62 miles) it's a routine pipeline job.

Then comes Orizaba with one of the world's most perfect climates, and beautiful to look at! And more difficulties!

This industrial city with Rio Blanco and other towns lie in a canyon for 20 kilometers (12.4 miles). The pipeline right-of-way goes between towns and mountains. As Mexicans of the poorer classes perch their flower bowered homes on steep rent-free slopes, the job might almost as well be on the main streets.

This absorption plant at Pemex City will feed gas to the pipeline for delivery to Mexico City and points enroute.

56 Miles of Hard Rock

Here, too, begins the 90 kilometers (56 miles) of hard rock. Terrain is about 90 percent rock. Compressors and rock tools and even dynamite must be used under the peering eyes of half a hundred bystanders. Children and grown-ups alike, fascinated by the strange antics of pipeliners, refuse to move.

Ahead other difficulties loom. If you've ever been to Mexico and motored to Orizaba and gardenia-glamored Fortin, you remember the spectacular view from the top of Cumbres de Maltrata. You remember too, if you're a nervous driver or passenger, the steep switchbacks that followed.

Mountains: 40 Percent Grade

Without benefits of switchbacks the pipeline climbs the mountain. In about 6 miles of going it gains almost one mile in altitude with the grade up to 40 percent. There is no trench digging here. No machine can ascend the slope, and if trouble comes emergency repairs would take too long. Instead pipe is embedded in concrete supports 3 ft above ground level.

For safety's sake the posts of the supports continue upward for another 3 ft. These supports also are used in some sections of the Omealca to Orizaba 35-kilometer (21.7 miles) stretch, which encompasses an ascent of 750 meters (2432 ft).

All pipe is coated and wrapped over the ditch with enamel, glass fiber, and outer wrapping.

Tubacero at Monterrey is making the 24-in. pipe, Tamsa in Veracruz the seamless sections for river crossings.

This new gas line is designed to carry 220,000,000 cu ft of gas without compressors. The initial flow to Mexico City will be 175,000,000 cu ft a day, with 45,000,000 cu ft used by industrial plants along the route.

Some months after completion it is planned to install two 7000-hp compressor stations, one in Orizaba, one farther along toward Mexico City. With these stations the load will be increased to 300,000,000 cu ft a day.

Personnel

Superintendent of this gas line from Pemex City to Mexico City is Ing. Xavier Peredo. He has had pipeline jobs ever since he left engineering school and acted as liaison official for Phillips Petroleum Company when they supervised the products line from Tampico to Monterrey.

Members of the advisory committee who act as consultants are three of Pemex's most experienced engineers: Ing. Eduardo Rugama, Ing. Hector Lara Sosa, and Ing. Bruno Mascanzoni.

In charge of swamps, lagoons, rivers, railway, and road crossings, is Ing. Xavier Benavides, who seems to have his work cut out for him! There are 50 railway crossings, 30 paved highway crossings, and a hundred or so country roads.

It looks, however, as though all the grief and money will be amply repaid. According to Petroleos Mexicanos officials, this gas line should save 450,000,000 pesos of liquid fuel a year. That will stop a lot of fuel importation, keep more dollars in Mexico, and give a big push to the nation's economy, they say.

★ ★ ★

Transco Crosses Hudson River with Dual Lines

CONSTRUCTION

FEATURE

Record speed made for river crossings in pulling 4200-ft line in less than a week

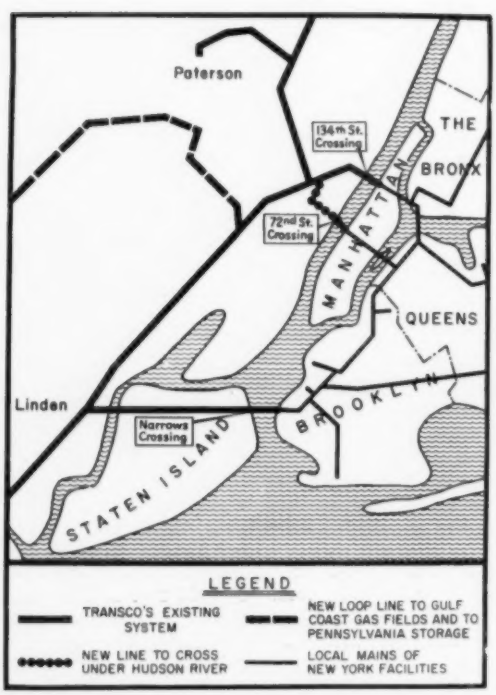
FOR THE THIRD TIME Transcontinental Gas Pipe Line Corporation has linked its 1840-mile system with the New York metropolitan area to bring increased gas supplies to consumers.

In pulling 4200-ft dual lines across the Hudson River in less than a week, Samuel Gallucci and Sons, Inc., prime contractors for the operation, and Collins Construction Company, specialists in underwater pipeline construction, set a new speed record for river crossing installation.

The crossing was made at 72nd Street where maximum depth is 50 ft below mean low tide; the river bottom is of hard mud with no rock. The current is swift, but this will not affect operations as the pipe was laid in a trench 20 ft wide and 25 ft deep, placing it 75 ft below mean low water level. Additionally, the pipe was covered by "select" backfill consisting mostly of sand. The fill amounted to 250,000 cu yd.

The pipe was 24 in. OD with ½-in. wall and was coated with 1-in. black mastic under a 2-in. layer of reinforced concrete. Pipe was trucked to the site in 40-ft joints and welded into 160-ft sections.

Launching was from a ramp designed by Collins Construction. The 160-ft sections were rolled onto the ramp and welded to the preceding sec-



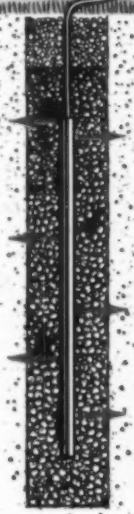
1. Transcontinental's third line to New York metropolitan area crossed the Hudson River at 72nd Street. Daily deliveries of gas are increased to 476,000,000 cu. ft.

2. Buoyed by massive pontoons, the dual pipelines, each 4200 ft long, were pulled from Manhattan to North Bergen, New Jersey.

WHEN BACKFILLING IS NOT PERFECT,

due to poor compacting or the inclusion of clods, rocks, or other obstructions,

DURIRON ANODES OUT-PERFORM ALL OTHERS



Duriron Anodes are better because they provide uniform current discharge over the whole anode surface

Duriron Anodes can be used with or without backfill

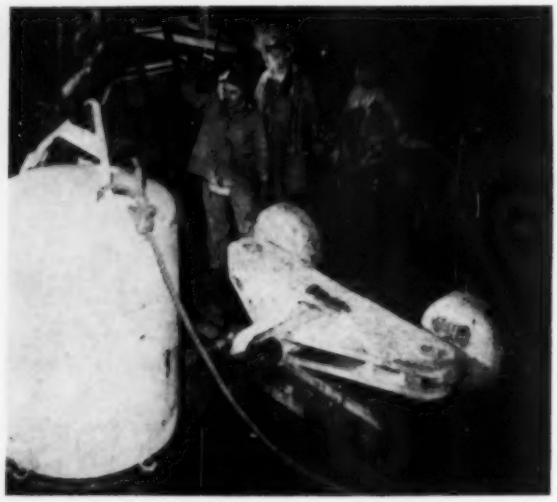
Duriron Anodes perform satisfactorily even when backfill material is not solidly compacted

Duriron anodes have a dense, homogeneous, metallic structure. They provide uniform current discharge with low consumption rates. Over five years of field and laboratory test data have proved that for the protection of underground structures, in every case Duriron will perform just as well as graphite, and in the really tough cases, Duriron performs better.

For complete details of Duriron Anodes for use in ground beds, fresh water, salt water and duct applications, ask for **Durco Bulletin DA/6.**

THE DURIRON COMPANY, INC., DAYTON, OHIO

BRANCH OFFICES: Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Detroit, Houston, Knoxville, Los Angeles, New York, Pensacola, Philadelphia, Pittsburgh, and St. Louis



3. Pulling caps were welded on the pipe heads. A yoke with a center eye was attached to both caps for single cable pulling.

4. The dual lines with pontoons attached slide into the water, guided by two supports, one 60 ft from shore, the other 120 ft.

tion. Welds were X-rayed and joints coated with concrete before sections were pulled into the water.

In this launching system the pipe rides on rubber-tired wheels, three to a set, the center wheel being vertical and the two outside wheels inclined to center. Twin sets were placed side by side to accommodate the dual lines.

Pulling caps or "nose cones" were welded on pipe heads, a yoke with a center eye then attached to both caps for single cable pulling. A "haulback" cable also was attached to the yoke for control and tension on the pulling cable. The haulback cable was attached to a winch on the New York side of the river.

Pontoons consisted of steel canisters 12 ft long attached to the pipes and steel saddles held the two lines together. Two supports, one 60 ft and the other 120 ft from shore, guided the pipes at a slanting angle to the bottom of the trench. The lines with pontoons attached were "slithered" across the river. Buoys marked each pontoon and when pipe laying was completed a boat hauled on the buoy line automatically cutting the steel straps that tied the pontoons to the pipe letting the pontoons float to the surface.

Transcontinental's first crossing of the Hudson was made at 134th Street, Manhattan, in 1950. A second crossing, under The Narrows of New York Harbor from Staten Island to Brooklyn, completed in 1952, provided an additional source of natural gas for the entire metropolitan area.

The Hudson River crossing ties-in with a new Consolidated Edison gas main crossing Manhattan in the vicinity of 72nd Street. As all other gas distributors in New York, Brooklyn, Staten Island, and Long Island are interconnected with Consolidated Edison, gas supplies can be drawn on as needed by any of them.

Daily gas deliveries to the New York area thus have been increased by 96,000,000 cu ft to a total of 476,000,000 cu ft. ★ ★ ★

5. Ends of pipes emerge on the Jersey shore. The lines are in a trench 20 ft wide and 25 ft deep, placing them 75 ft below mean low water level.

6. Victor Gallucci, prime contractor, and Sammy Collins, underwater pipeline specialist, greet the lines with champagne as they come out of the water.

Humble Modernizes Old Pipeline Systems to

Reduce Operating Costs

Two independent closed systems made from 8 and 12-in. lines installed in twenties, with intermediate booster stations controlled remotely

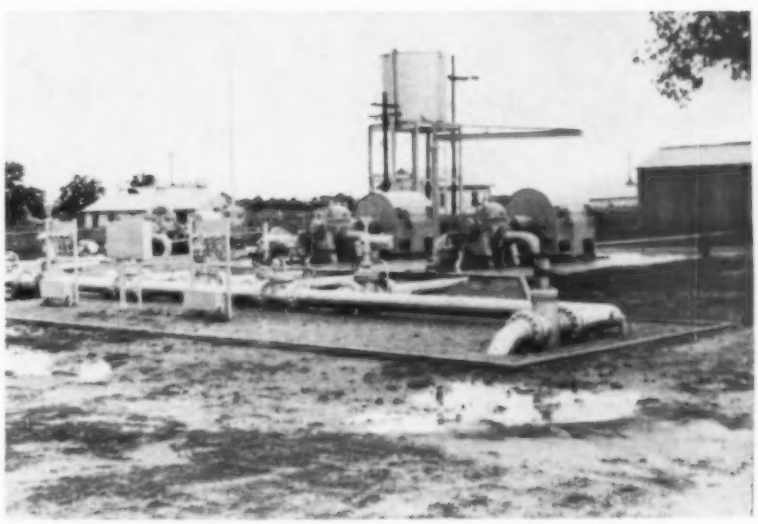
W. L. Moore, *Senior Supervising Engineer*
I. B. Cloessner, Jr., *Electrical Engineer*
Humble Pipe Line Company

HUMBLE has just completed an updating program on its multiple 8 and 12-in. pipeline crude oil systems from both North Texas and East Texas to the Gulf Coast. These lines were laid and pumping stations built in the early and middle twenties. Need for changes was brought about by high overall operating costs and excessive losses from evaporation in tankage.

Pipe in all lines shown in the schematic diagram is lap welded with screw coupled field joints. Many of the collars had been welded to the pipe, bad pipe sections replaced, and parts of the lines recoated during reconditioning work in the late thirties and middle forties. These major reconditioning projects were not necessary after corrosion control techniques were perfected to the extent that comparatively few corrosion leaks occurred.

Adequate protection from corrosion was being provided before recent changes at a very nominal cost, even though the coatings are only fair. Condition of coating no longer determines the speed of deterioration by corrosion but merely the amount of electric energy required to provide protection.

The pipeline system of 8-in. and 12-in. lines from North Texas is equal in oil moving capacity to a line of 12¾-in. inside diam. It had sufficient capacity for foreseeable needs, but each of the four sections was operated as a complete pipeline in itself. At each station, diesel-plunger units took suction from tanks "floating" on the line and pumped at 725-psi discharge pressure through the lines into a tank at the next station. At Hearne, the second of three intermediate stations, the system from North Texas converges with a 12-in. line from East Texas. Here oil from the two converging streams flowed into 18 tanks of 62,000 bbl average size.



Hearne, a typical remotely controlled intermediate booster station.

Need for Changes

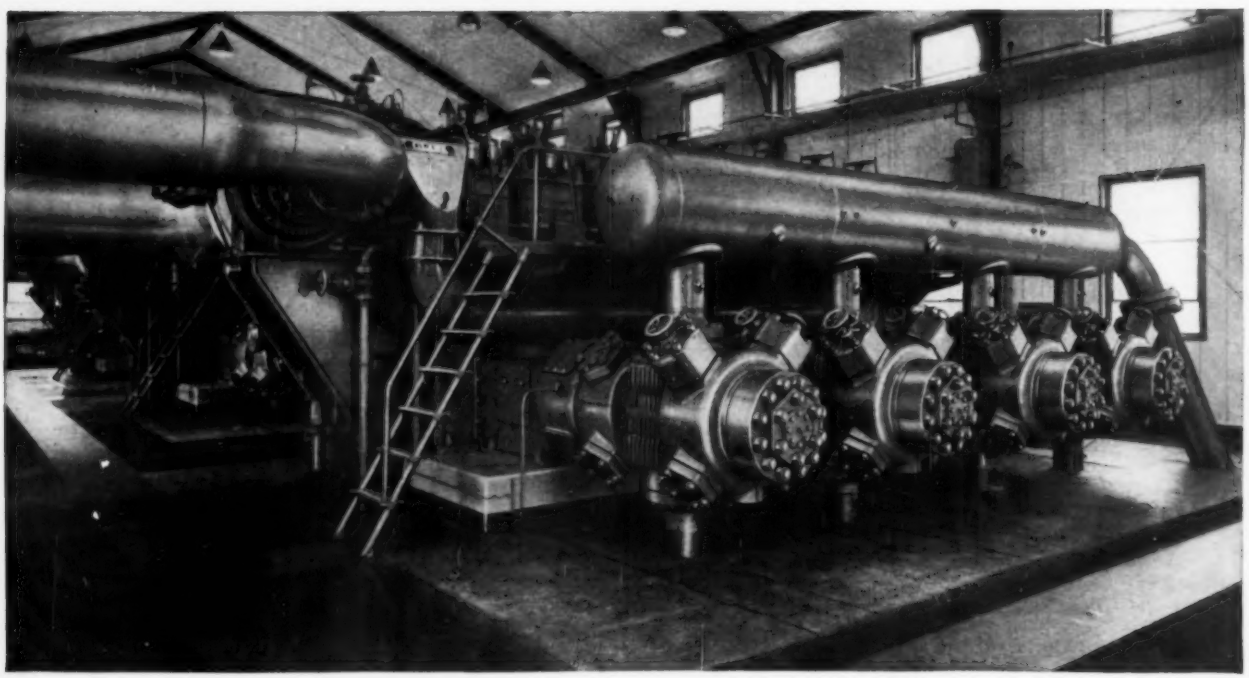
After investigating the reasons behind high operating costs and possible ways to reduce them, the key was found to be:

Cut operating tankage to a minimum consistent with the primary goal of providing a maximum of service as a common carrier.

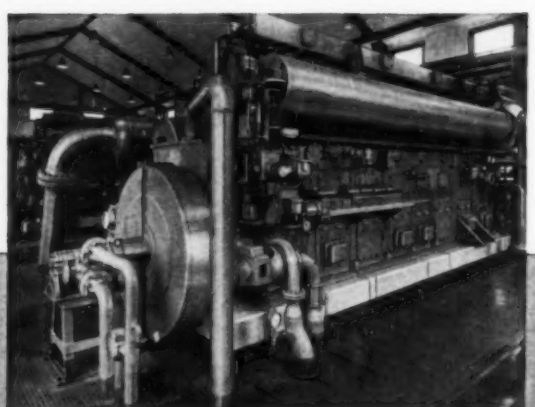
Manual operation of these stations and tank farms including batching of two to five grades of crudes was an expensive operation. Evaporation losses from tankage at these intermediate stations were high. Most tanks had fixed cone type roofs.

It was found that by a reallocation of some of the 8-in. loops south of Hearne, two independent closed systems could be set up — one for North Texas and the other for East Texas crudes. Each system would be closed, without intermediate tankage, and could easily be operated by remote supervisory control from either the initiating station or from a central dispatchers' office. The initiating station on each system was chosen for this control because of the large amount of tankage at each and the expense required to remotely operate tankage and

PUSHBUTTON CONTROL



Three Clark 2050 bhp. HBA-8 turbocharged, gas-engine-driven compressors on stream in Texas Eastern's Linden, N. J., Station.



Notice how all functions are designed for automation. Hydraulic pump for radiator fan drive and water pump for jacket water are driven off of the compressor crankshaft.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

FROM 40 MILES AWAY

FOR ONE OF TEXAS EASTERN'S NEW COMPRESSOR STATIONS

At Linden, N. J., three 2050 bhp Clark turbocharged, gas-engine-driven compressors are under the complete supervision of an operator 40 miles away. From his control point upstream at Lambertville, the operator starts and stops the engines, adjusts speed, and keeps tabs on engine, compressor and pipeline functions which are displayed on the remote control panel.

Each of the Clark units at Linden may be controlled at from 60% to 110% of rated speed with constant torque loading. The pneumatically operated and remotely controlled compressor valve lifters and clearance pockets permit full utilization of the high flexibility inherent in these reciprocating compressors.

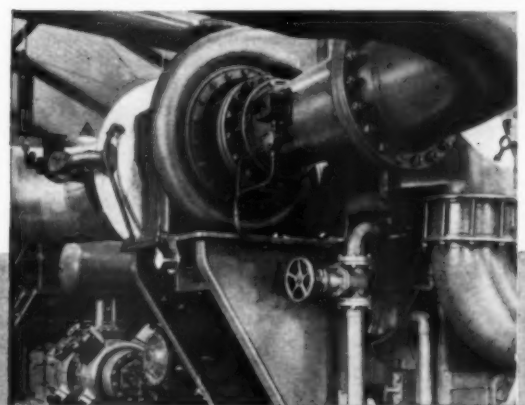
This is just one example of how Clark 2-cycle pipeline compressors are being used for automatic operations. As the trend toward more complete pipeline automation develops, look to Clark for the engineering know-how and the manufacturing experience to produce compressors that readily lend themselves to any degree of sequenced, automatic or remote control.

If you are considering pipeline expansion, it will pay you to learn more about Clark equipment and what it can do for you. Your inquiries are invited. Write:

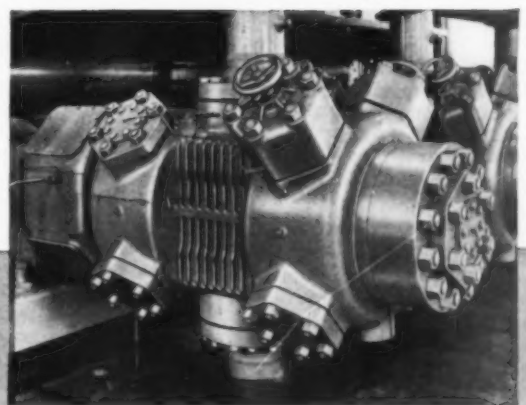
CLARK BROS. CO.
OLEAN, N. Y.

COMPRESSORS
GAS TURBINES

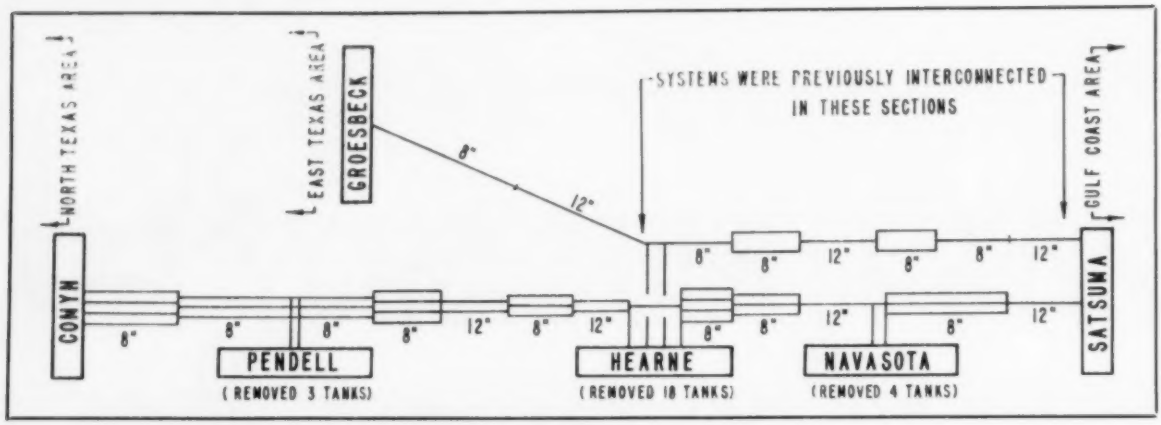
CLARK



Clark Turbocharger and intercooler are mounted on the oil pump end of engines. Increased horsepower and improved fuel economy are direct results of turbocharging.



Clark Low Ratio Pipeline Compressor Cylinders are also designed for automation. Pneumatically operated valve lifters and clearance pockets are provided. Hand adjusted valve cap pockets provide additional capacity control.



Schematic of crude oil lines that were updated.

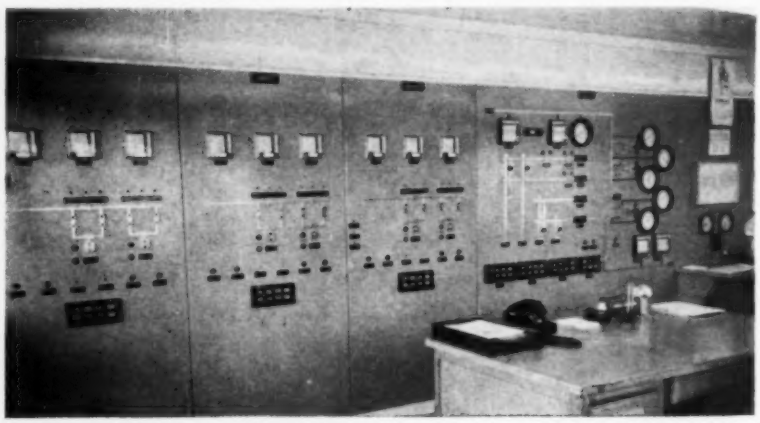
all associated facilities. Also, some direct control could be exercised if remote control were lost.

Some factors in the proposed operation made it imperative that most of the 8 and 12-in. pipe in these systems be hydrostatically tested before placing into closed system operation. Higher pressures would be required merely to retain existing capacities because of the batching operation — the section with most viscous crude would always limit the pumping rate for entire system. A "water hammer" surge pressure due to intermediate stations shutting down would cause a further rise of approximately 200 psi above normal pressures. Much of this old pipe on the upstream side of intermediate stations had never been subjected to pressures above 50 to 200 psi, but would be pushed up to 500 to 700 psi in the closed systems. These higher pressures could have caused enormous oil losses from corrosion pit holes that had not leaked but would be opened by the increased pressure.

Hydrostatic Testing of Lines

Split joints were anticipated from experience with other lines tested during the previous five years. The only trusted solution was to hydrostatically test all pipe in these lines to a pressure calculated to be above that to which the lines would later be subjected. That desired pressures could be attained was certainly not known because of doubt as to the original quality of the pipe and the extent to which corrosion had weakened it.

Two previous hydrostatic tests of old 8-in. crude lines had shown the value and reliability of such tests. In 1954 one line that had operated for 30 years at 700-psi maximum pressure was tested to 1300 psi and has operated without incidents since at 1125 psi. Another that had been in sour crude service for 30 years operating at 700 psi was tested to 1200 psi and has operated since at pressures up to 1000 psi including water hammer surges.

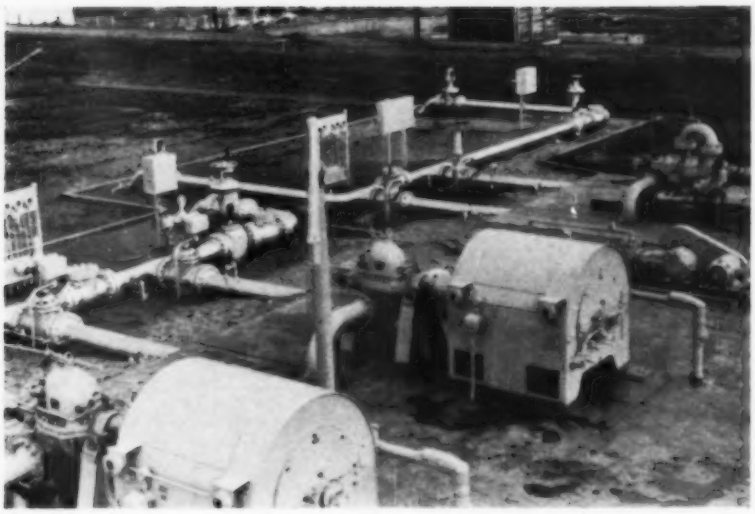


Control panel at Comyn. The three similar sections on the left are for the remotely controlled stations: Navasota, Hearne, and Pendell. Next to the right is for control of the local station at Comyn. At the far right is a tank gage receiver for all tanks at Comyn. On Comyn panel counters can be seen for meters on the two incoming streams and the two outgoing streams.

Previous high operating pressures on subject lines varied from 725 psi discharge at each station to 50 psi on the downstream ends. In the planning stages many uncertainties existed. To what pressure could these old lines be tested? How many failures might be expected? How would small leaks be located? What would be the cost of this testing? Even though the testing has now been completed successfully, the answers we got to these questions would not necessarily apply to the next job.

First, the established goal for test pressures was 1200 psi for the 8-in. and 1000 psi for the 12-in. The planned closed line operation at 850 psi discharge pressure would subject the pipe to 500 to 1050 psi, including surges, depending on which stations were operated. Assuming a longitudinal joint factor of 0.80 and a minimum yield of 25,000 psi for the Class A equivalent lap weld pipe, 68 percent of the adjusted minimum yield would be reached during operation. The 8-in. pipe was actually tested to pressures from 1100 psi (72 percent of MY) to 1200 psi (78 percent of MY). The 12-in. was subjected to pressures from 925 psi (77 percent of MY) to 1000 psi (83 percent of MY). Leaks that occurred during this testing are summarized in the accompanying table:

	551 Miles of 8-in.		152 Miles of 12-in.	
	No. of leaks	Leaks/mi	No. of leaks	Leaks/mi
Split in longitudinal welds	106	0.19	34	0.22
Leaks from screw collars	174	0.32	22	0.15
Leaks from field welds, pit holes and other miscellaneous	99	0.18	104	0.68
TOTAL LEAKS	379	0.69	160	1.05



Closer view of a part of the equipment at Hearne and lines of the two systems.

Some low operating pressure portions of the lines were not tested because of the need to get the entire systems back into service. Both the time required to test and the testing costs were in excess of estimates. Testing was carried out independently in the three operating divisions on different sections of the lines during a five-month period. Costs directly chargeable to the hydrostatic testing were over the amount originally estimated. The lines were brought up to standard with modern scraper traps and steel valves.

Pressure testing equipment included engine-driven multistage centrifugal pumps for filling lines at high rates from streams or tanks and either 8 or 10-in. stroke piston pumps for pressuring the lines.

Discouragement came in some instances when a pipe section would fail at a lower pressure than it had been subjected to previously; however, this was the exception. Split pipe failures most often were attributed to poor quality mill joints instead of deterioration from corrosion, although corrosion may have contributed to the failures by weakening the joints. Greatest initiative of people in charge of the testing was required in locating the many small leaks. Rainy weather contributed to the problem. On occasion, leaks from several small holes and seeps would exceed the capacity of pressuring pumps. Due to the rainy weather and localized soil conditions some of the small leaks were located only after lines were returned to oil service.

Design of New Stations

Design of remotely controlled booster stations was guided by these goals: (1) Simplicity for easy operation and maintenance and (2) complete self protection of pumping equipment without compounding of devices. Auxiliaries consist of an automatic sump pump at each station and air compressors at Comyn and Hearne only, where pneumatic pressure controls are used. Communication and electrical switchgear are housed in a steel frame building but all main line pumping units are installed outside. New motors have Type II weather protective enclosures but old open motors used were fitted with simple sheet metal hoods.

Remote Control and Telemetering

As previously stated, all pumping units at the intermediate booster stations are completely self-protected against malfunction. Automatic sequencing equipment incorporated into the electrical switchgear requires only the initiation of starting and stopping sequences by the supervisory control equipment.

The ability of the operator at the controlling station to perform these control functions, consistent with efficient utilization of the pipeline system is limited by his knowledge of conditions at each booster station. Separate mimic bus control panels depicting the status of each booster station provides this necessary intelligence. Controls, indications, alarms, and telemetered data on a typical booster station control panel are:

Controls —
Start and stop each of two units.

Unit lamp supervision —
On-off each unit.

Open-transit-close conditions of suction and discharge valves for each unit.

Unit malfunctions —
Electrical, mechanical, and operations failure for each unit.

Station malfunctions —
High discharge pressure, low tripping battery voltage, and high sump level.

Other indications —
Loss of indication or control circuits.
Local control of a booster station taken by maintenance personnel.

Telemetered data —
Suction, station discharge and line pressures for each station.

All malfunctions are indicated by lamps and accompanied by audible alarms. Telemetered pressures are displayed on miniature strip chart recorder.

A separate but adjacent control panel provides indications and controls

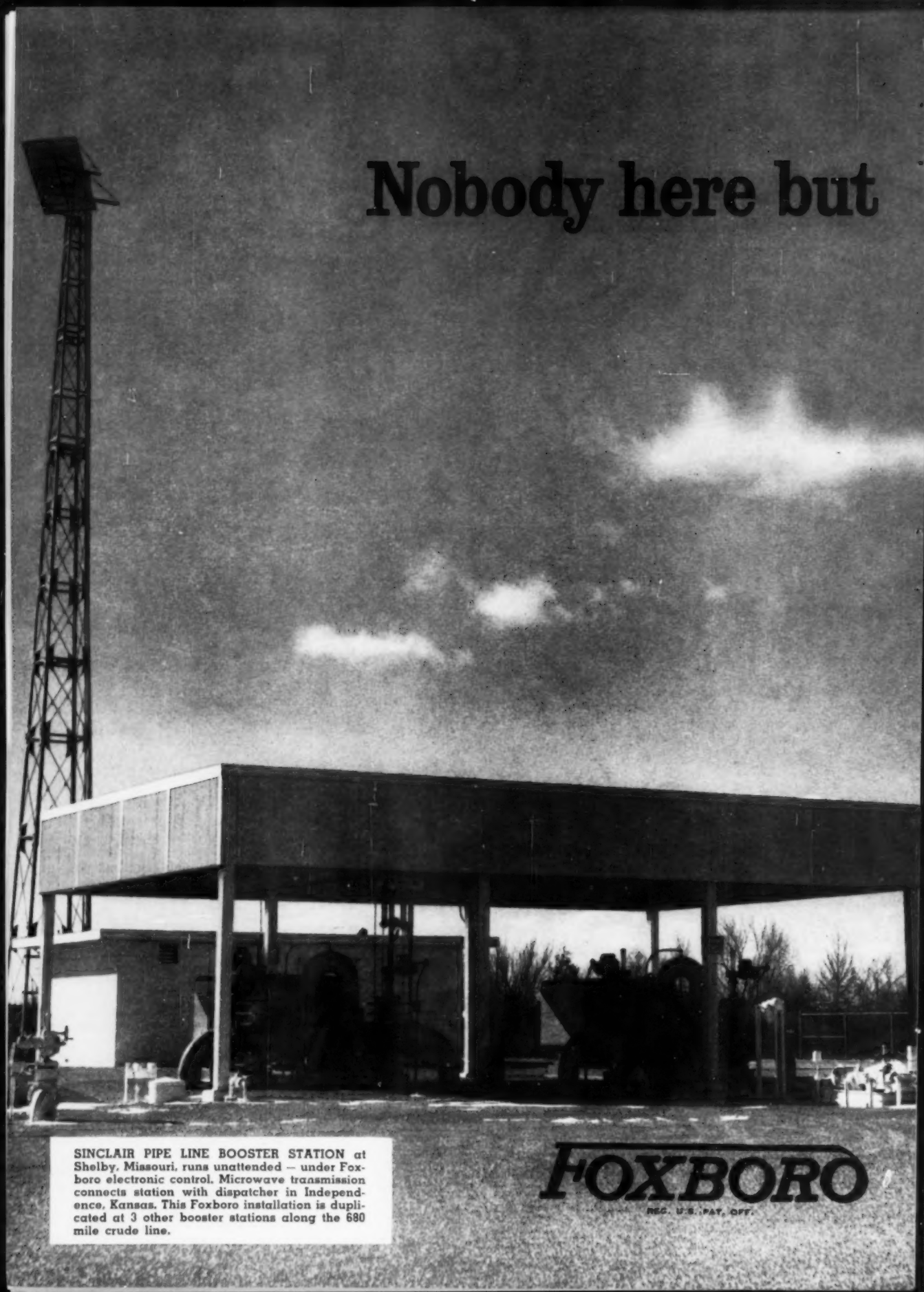
---

W. L. Moore

I. B. Cloessner, Jr.

W. L. Moore received a BS degree in mechanical engineering from University of Texas, June 1946, and began work in August for Humble Pipe Line Company in Houston as junior mechanical engineer. Has worked on various engineering assignments for Humble since that time and is now senior supervising engineer in the Technical Department, Major Projects Division.

I. B. Cloessner, Jr. was graduated from Louisiana Polytechnic Institute July 1947 with a BS degree in electrical engineering. Was employed in September 1947 by Humble Pipe Line Company at Ingleside, Texas, as a junior engineer in the Communications and Electrical Department. November 1950 to November 1952, served in the U. S. Army at Edgewood, Maryland, in a Chemical Corps research laboratory. Upon release from active duty, returned to Humble. June 1956, was transferred to present location in Humble's Communications Division, Houston Office as electrical engineer.



SINCLAIR PIPE LINE BOOSTER STATION at Shelby, Missouri, runs unattended — under Foxboro electronic control. Microwave transmission connects station with dispatcher in Independence, Kansas. This Foxboro installation is duplicated at 3 other booster stations along the 680 mile crude line.

FOXBORO

REG. U.S. PAT. OFF.

Foxboro Electronic Control!

Sinclair Pipe Line Booster Stations Run Unattended Since 1957 Start-Up

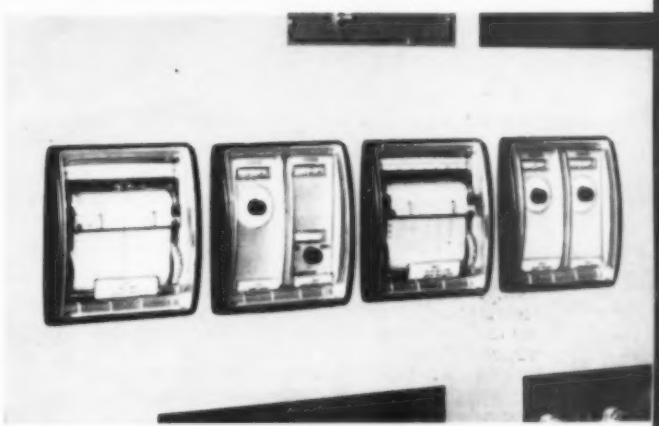
Two years ago, Sinclair Pipe Line Company added four new booster stations to its Cushing-to-Chicago crude line. Stations had to run unattended weeks on end — routine maintenance had to be kept to a bare minimum.

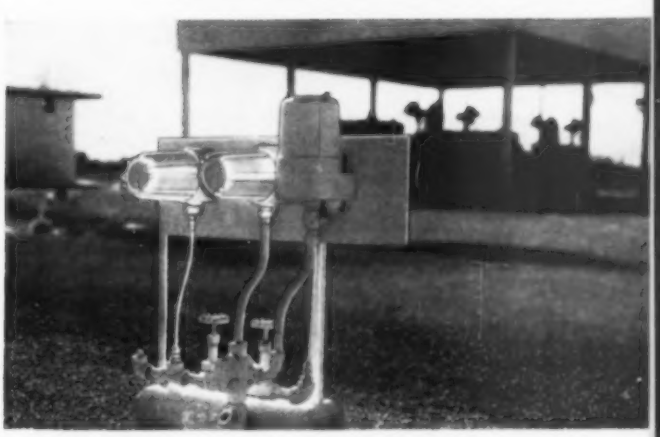
"Foxboro electronic Consotrol* instruments proved an excellent solution," Sinclair engineers report. "We eliminated air compressors, dryers, valve boosters, and other high-maintenance equipment. And we gained the faster control of electronics—important on a crude line as large as ours."

Sinclair's maintenance record shows that Foxboro electronic instruments require practically no attention.

Your operations also may benefit trom a specially designed Foxboro electronic Consotrol system. There are instruments for every function in the control loop — all 100% solid state, for greater dependability and least maintenance. Get full details by writinq for Bulletin 21-10A. **The Foxboro Company, 389 Neponset Ave., Foxboro, Mass.**

*Reg. U. S. Pat. Off.





Top — Foxboro electronic Consotrol instruments for triple auto-selecfor control of pump suction pressure, discharge pressure, and motor load. System also continuously records these variables on 30-day strip charts. Instruments — checked frequently since November, 1957 — have required practically no attention.

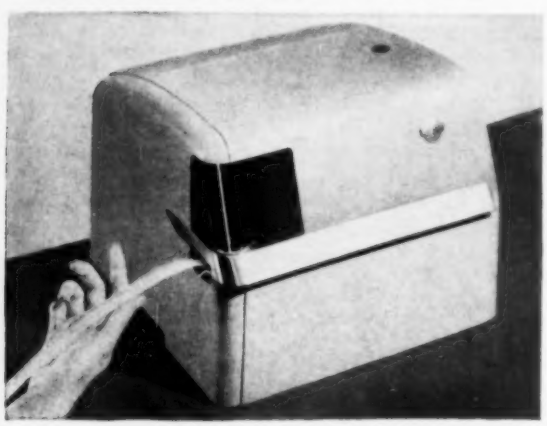
Bottom — Foxboro electronic pressure transmitter (left) delivers high-level d-c signal to control panel. Shown at right is high-limit pressure switch.

electronic Consotrol instrumentation

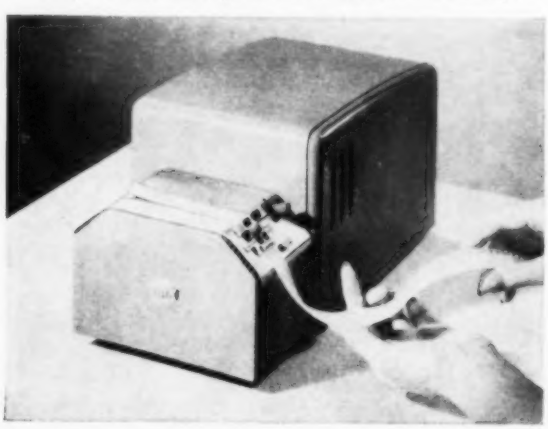
Teletype Model 28 Automatic Send-Receive Set A "complete station" in one console—with facilities for sending and receiving on message paper or sprocket-fed business forms . . . tape punching . . . sending or receiving with tape . . . integrating tape and manual keyboarding . . . producing tape automatically, as a by-product of send-receive operations.

Teletype Model 28 Receive-Only Page Printer A message receiving unit (without keyboard). This is "terminal" equipment, for use where two-way communication is not necessary. No attendant is needed. Produces a printed record on plain paper or multipart business forms. Table models of this unit and the send-receive set at the right are also available.

Teletype Model 28 Tape Punch Receives incoming electrical signals, punches a 5-level "common language" tape, and prints data right on the tape, for easy identification and handling. Unit is used for message relaying . . . for integrating data from several sources into a single tape . . . for providing punched tape as a by-product of send-receive operations.



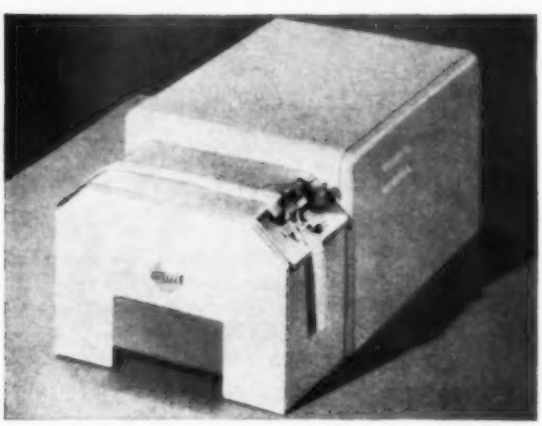
Teletype Model 28 Tape Reader This is a sending unit. Reads punched tape and instantaneously transmits data to local or remote receiving equipment. As with all Teletype transmitting units, data may go to one destination or a number of destinations simultaneously—either nearby or thousands of miles away.



FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Teletype Model 28 Send-Receive Page Printer Message originating unit, for sending and receiving. Model 28 page units, including the Automatic Send-Receive Set, feature a built-in "stunt box" control system for automatic station selection and electrical control of remote equipment. Horizontal tabulation and form positioning arrangement available.

Teletype Model 28 Tape Reader—Twin-Shaft Unit is similar to tape reader at left. Besides reading punched tape for on-line transmission, twin-shaft reader-distributor design offers facilities for tape transmission to business machines and direct read-out, from business machines, for on-line transmission.



Applications unlimited . . .

TELETYPE Model 28 Line

For communications systems—on-premise or nationwide . . . data handling . . . mechanization . . . automation . . . telemetering.

Presented here are the principal units of the Teletype Model 28 Line. "Model 28" stands for an entirely new concept in record communications. It is an integrated line, designed on the modular principle, permitting a wide choice and ready interchange of components and providing accommodations for expansion. Typebox printing on page units makes possible quick interchange of alpha-numeric characters. Speed is 600 characters per minute with printing, up to 1,200 characters per minute on tape units where printing is not required.

These new machines are manufactured to Teletype's precision standards for continuous day-in and day-out service. Operation is not affected by tilt or vibration. All-steel clutches and simple harmonic design elements reduce and simplify maintenance; oiling is needed only once or twice a year.

Exclusive with the 28 Printer Line is the versatile Stunt Box, which is actually a "robot brain." It responds to keyboard or line signals, and may be used for internal control of extra functions in the Teletype printer and for remote control of Teletype or other electronic or electro-mechanical equipment.

The Teletype Model 28 Line opens new areas of applications in data communications. In addition to the self-contained units shown here, components are available to system manufacturers for integration with their equipment. The tested dependability, accuracy and adaptability of Teletype equipment make it ideally suited for system applications.

More information. If you would like more information on Model 28 equipment or components, please write to: Teletype Corporation, Dept. 90-J, 4100 Fullerton Ave., Chicago 39, Illinois.

TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.

for the local initiating station; thus operating personnel at the initiating stations, Groesbeck and Comyn, are presented with a continuous picture of conditions at all points on their respective pipeline systems.

Normally, the type of supervisory control and telemetering equipment selected is limited somewhat by the availability and lease costs of communications circuits. The selection of equipment for these systems was not limited, however, by this factor since all communications facilities utilized were company-owned. Adequate spectrum space permitted the installation of an analog time-duration telemetering system. Installation of single-station supervisory control equipment permits the independent control and supervision of each booster station. Some of the features of the supervisory control equipment are:

1. All-relay, relatively slow pulse rate utilizing 0-15 cps circuits.
2. Transmits composited pulse code whereby all indications from a booster station are contained in a single transmission. All control functions may be contained in a single transmission if desired.
3. Verification of transmitted codes is accomplished by totalization, monitoring of each code step for proper length, and by checking the number and order of long pulses.
4. Rejection and automatic recall of invalid indication codes.
5. Automatic transmission of indication codes upon restoration of power, or communications circuits after failure of either.
6. Loss of control circuit does not prohibit transmission of indication codes.
7. Control codes in storage or in progress may be cancelled, and a check of all indications may be requested by operation of appropriate pushbuttons at the controlling station.

Unusual Features

Some features of the design may be of special interest:

1. At two of the intermediate stations, double-ported throttle valves are positioned with hydraulic fluid from a small electric powered pump. Hydraulic suction and discharge pressure controllers regulate the flow of hydraulic fluid to the throttle valve cylinder type operator. This simple floating type control is ideal for pipeline use. Stroking time for the 10-in. valves had to be reduced to 15 sec to prevent nuisance shutdowns. Faster stroking may yet be required to more nearly equal the 5 to 10 sec stroking time of pneumatic systems. Neither flow control nor remote set points are used on the pneumatic or hydraulic control systems.
2. Meters of positive displacement and turbine types are to be used for the accurate measurement of crudes into and out of these systems. We get many advantages over tank measurements, including more accuracy with less reading effort, freeing of tanks, over and short operation of tankage allowing smaller manifolds and less lag in checking of line operation.
3. Electronic calibrated-pipe proving avoids starting and stopping of meters. The first full scale prover of this type is installed at Comyn. It offers many potential advantages over other meter proving methods for increased accuracy, speed, economy, and further automation.
4. A rate of flow device is used on the line to each pump instead of a case temperature switch. They have theoretical advantages but improvements are needed yet to make them completely reliable.
5. Header valves at the downstream end of the systems are closed automatically in response to a low flow signal from the same type devices used to protect pumps. By closing these valves at a rate of flow slightly above gravity flow all lines are kept liquid filled.
6. At the initiating station on each system tanks are divided into three groups, one for each of the two grades of crude and the third as standby or overflow storage. Each group is worked as a battery of tanks with positive displacement meters on each fill and suction line.

Conclusions

Hydostatic testing should be used more extensively to prove and upgrade old lines and possibly as an operating tool for preventive maintenance during periods of reduced throughput.

Four months operation of this modernized and remotely controlled system has pointed up the need for further improvements of protective devices and a greater emphasis on specialized training of personnel who are to operate and maintain these new type systems. ★ ★ ★

Coal Mine Tested for Gas Storage

Conversion of a coal mine to a storage vault for natural gas is being undertaken for the first time anywhere in the world by Public Service Company of Colorado. Intensive testing operations currently are underway at the Leyden Lignite Mine seven miles northwest of Arvada to determine whether it is gas tight. If found to be so, the mine will be developed for permanent storage for natural gas to be used for peak shaving during the heating season, a move that will greatly relieve the Denver area's present gas supply problem.

An estimated 3 billion cu ft of gas could be stored in this cavern at a pressure of 300 psi.

The mine was nearly filled with water when the tests began. To test it for tightness, gas under pressure is being injected through a 975-ft well drilled into the north end of the cavern, from where the core seam slopes downward some 200 ft to the south. As the tests progress, increasing volumes of gas will be injected, forcing water from the mine back into its source or to the surface through another well to be drilled into the low south end of the mine. An estimated 1.3 billion cu ft of gas at 130 psi will be needed to hold back the flow of water into the mine once the water present is pumped out.

If this portion of the mine is found to be gas tight, the mine's four shafts will be sealed and the rest of the mine filled with gas to test the entire vault.

Rock cores taken during the drilling of a first well, and other preliminary investigations, indicated that rock strata above and below the coal seam should form a gas-tight seal. It is possible, however, that porosity in the rock strata or the coal seam may permit gas to escape. If such is the case, silicon tetrachloride gas will be injected into the mine. This gas has an affinity for water and water vapor, and will build up a deposit of water glass on the grains, plugging the porous sand.

If found gas tight, four additional wells will be drilled for injecting and withdrawing gas.

An 8-mile pipeline has been built for gas injection and a 22-in. delivery line will be laid from the mine to 88th and Carr streets in Denver. Gas compression facilities of 11,320 hp, as well as regulating, metering, and dehydrating equipment will be installed.

An estimated five years will be needed to complete the project, although storage may begin in time for the 1959-60 heating season.

How PG&E Monitors Its Super-Inch for Rupture

James H. Stannard, Jr., *Gas Engineer, Pacific Gas & Electric Company* **Tod Morcott,** *Sierra Electronic Corporation*

ALMOST ALL gas requirements of the San Francisco area are met by Pacific Gas and Electric Company's 500-mile, 34-in. line that runs from Topock, Arizona, across the Mojave Desert, the Tehachapi Mountains, and up the San Joaquin and Santa Clara valleys. The line crosses some of the most desolate terrain in North America; often, the nearest maintenance station is 75 miles away.

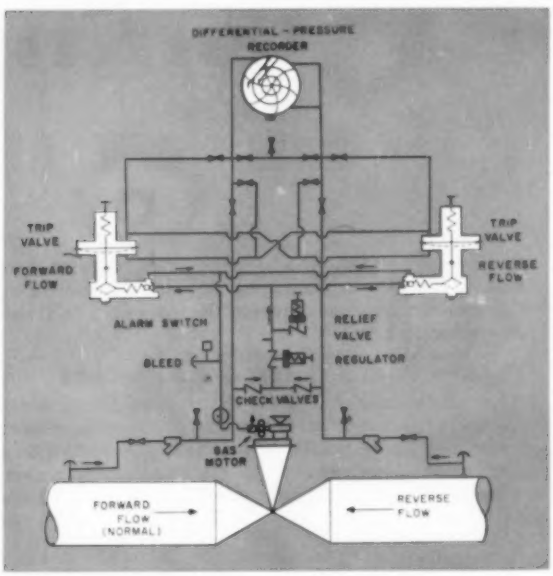
In the past, PG&E has relied on two telephone lines that run parallel to the pipeline for communications. Pressure telemetering stations were installed every 50 miles to furnish information on line breaks, etc. Because of difficulties in interpretation, many hours would likely be wasted in trying to isolate a leak. In the interim, the inventory of gas contained in 150 miles of line could be lost.

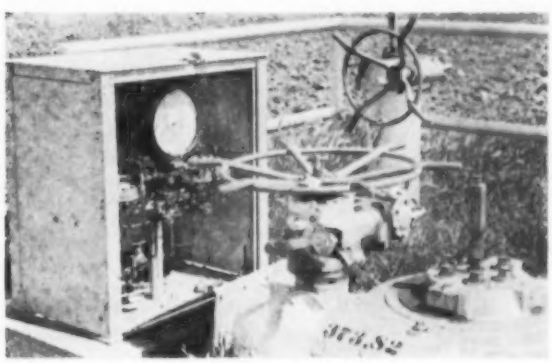
PG&E management decided to equip a number of strategically located valves and the pressure limiting stations along the line with automatic equipment that would (1) **sense any major break,** (2) **initiate valve closures to isolate a ruptured section, and** (3) **report the location of the trouble to the nearest attended station.**

Sensing and Control Actuator

The system adopted by PG&E to detect line breaks utilizes the line valve as a differential metering device. The differential sensing device will detect either an abnormal or reverse flow and, in turn, initiate a valve closure. How the system operates is shown in the accompanying schematic. Note that the actuating energy comes from gas pressure in the line. The differential control valve has a snap action, and once tripped it will remain in open position until reset. This insures that the gas-driven valve motor will completely close the main line valve.

The small lines running from the trip valves to the pneumatic motor on the main line valve contain a pressure switch that will initiate an alarm function.





Communications for the Alarm System

When PG&E's line was first built, it was equipped with a single open pair telephone circuit. The physical circuit is used for telemetering, teletype, etc.

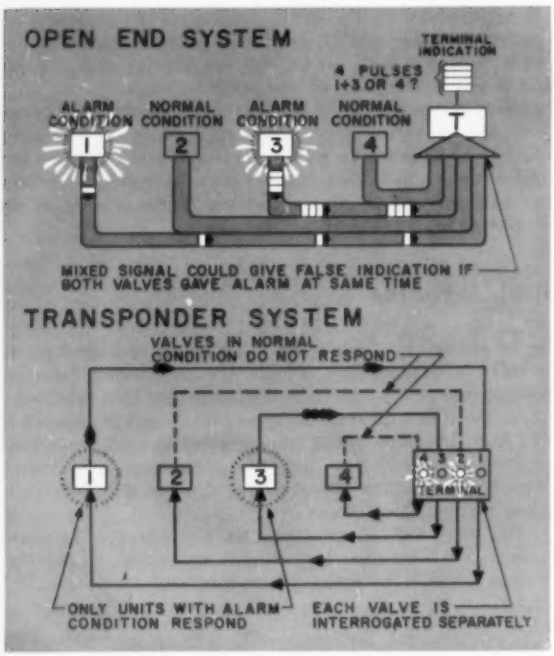
Physical circuit. On first investigation it became obvious that the carrier signaling was preferable to the physical circuit in the alarm system because dust and lightning in the desert build up 200-v static charges, which are discharged across protective spark gaps. This gives low frequency saw tooth waves with harmonics up to 3 or 4 kc, rendering the physical circuit useless.

Standard telemetering vs coding. While standard carrier frequency telemetering is simple and adequate, it would re-

Presented before Pacific Gas Association, San Diego, California.

quire 20 channels, taking up most PG&E's valuable frequency spectrum on already crowded telephone lines. To conserve spectrum, some coding method would be necessary.

Two coding systems. The two methods used to code alarm devices are the *open-end system* and the *transponder system*. In the first method, the remote alarm unit transmits a coded identification signal which the terminal equipment records. The primary objection to such system is that if two valves were activated at the same time, their signals might interfere and give a false indication.



Transponder Systems

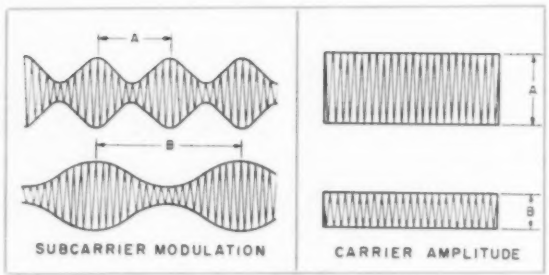
This system operates as follows: The terminal equipment interrogates the various alarms and only those units in an alarm condition respond. Thus the system is free from mutual interference; the operator at the terminal has the opportunity to re-check his data in event of simultaneous operation of the remote equipment.

Methods of Coding Information

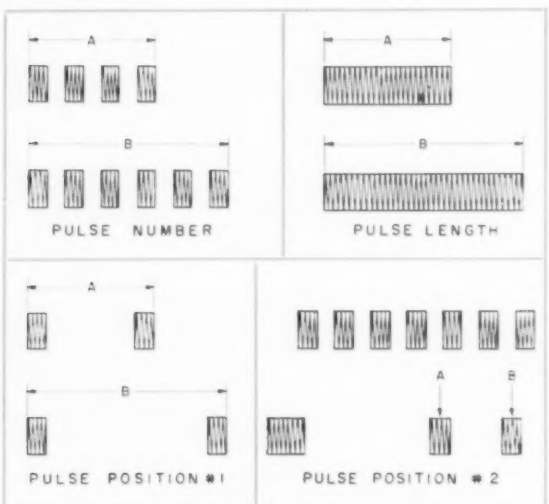
Interlocked with the choice of the general system is the method of coding information. These methods are shown below:

Sub-carrier modulation. Frequently used commercially; however, it requires as much frequency spectrum as individual carrier frequency telemetering sets. Equipment required is complex and costly.

Carrier amplitude. This is a very simple method. However, it requires almost continuous maintenance. Another disadvantage is that telephone line loss characteristics vary with weather.



Pulse coding. There are three types of pulse coding.
Pulse number. This is the most common, being used in the dial telephone. Best suited for an open-end system.
Pulse length system. The duration of the various pulses gives the coded information. Commonly used in the gas industry.



Pulse position method. The time between pulses may indicate the code, or the number of pulses transmitted by the terminal equipment between the two pulses may also determine the code.

HOW PG&E'S ALARM SYSTEM WORKS

After considerable study, PG&E with the aid of Sierra Electronic Corporation of Menlo Park, California, elected to install a two-tone transponder system. The system consists of **remote alarm units** located at the line rupture valves, and **terminal alarm equipment** at the various attended stations.

Remote alarm units are comprised of transistorized carrier frequency transmitters and receivers, associated relays, power supplies, and manual test switches. Transistor circuitry was employed for two reasons: Lower power drain and reliability.

Terminal alarm equipment consists of two carrier frequency receivers, one transmitter, and relay and display panels. The relay panel contains a selector switch, control, and holding relays. The display panel includes indicator lights, alarm re-set switch, and test switches. A terminal alarm unit is located at each end of the line under surveillance.

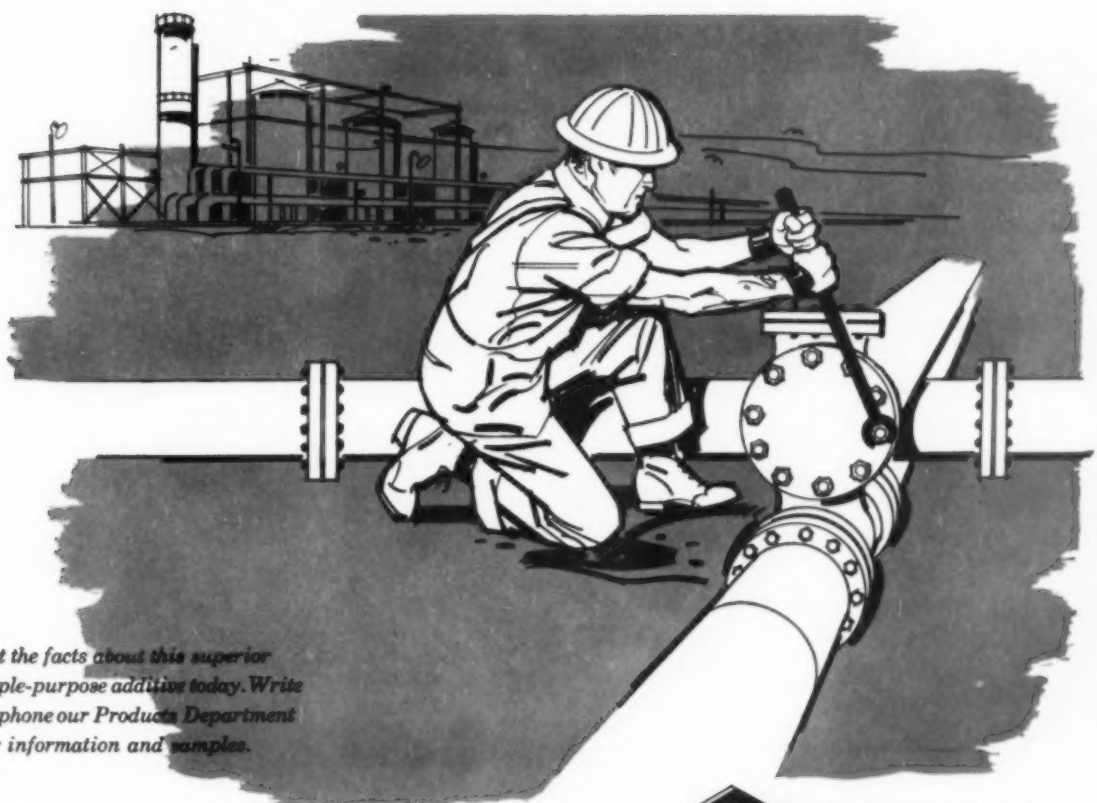
Propane-soluble additive **UNICOR LHS®**

proves superior as detergent, corrosion inhibitor or anti-icer!

Added to your gasoline as anti-icer, UNICOR LHS does an effective job in preventing carburetor icing and consequent stalling. In addition, UNICOR LHS imparts greater detergency to your gasoline than the best competing additives —and at lowest cost.

But in addition to improving the quality, and hence the salability, of your gasoline, UNICOR LHS performs these money-saving services for you:

A surface active additive, soluble in all hydrocarbons including liquid propane, UNICOR LHS safeguards pipelines and refinery equipment against corrosion. It is also a highly effective detergent—eliminates troublesome deposits in heat exchangers, promotes cleanliness of refinery equipment.

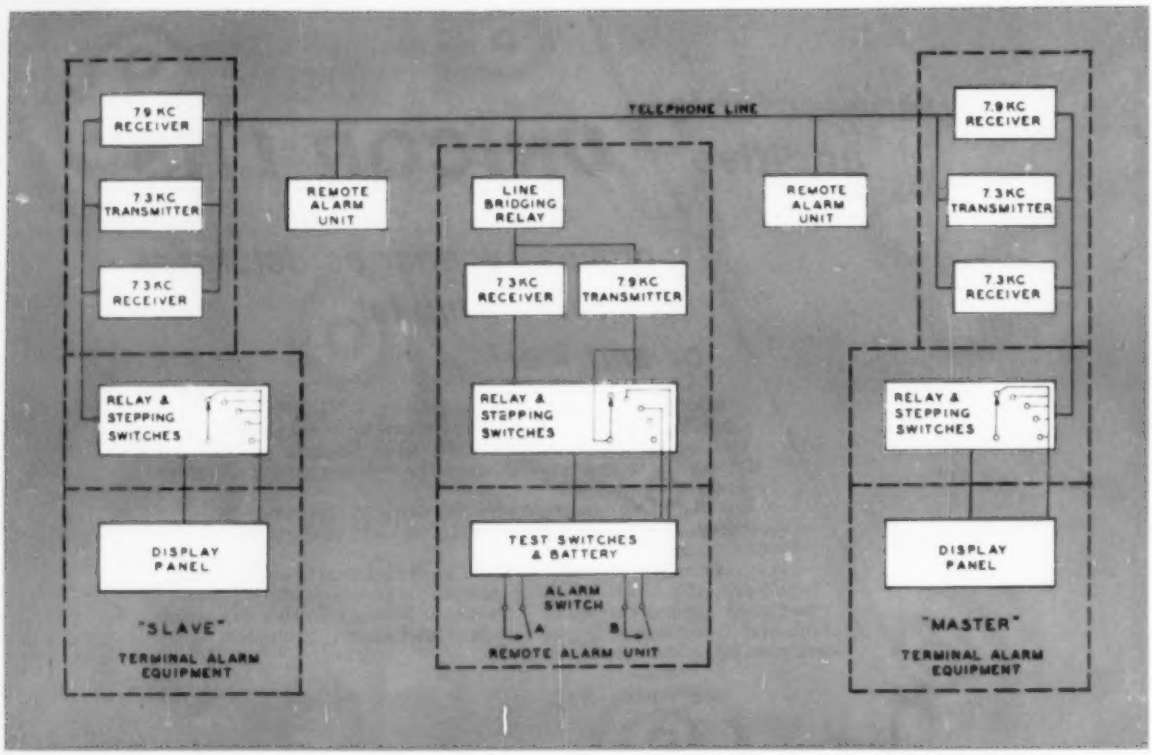


Get the facts about this superior triple-purpose additive today. Write or phone our Products Department for information and samples.

UNIVERSAL OIL PRODUCTS COMPANY UOP®

30 Algonquin Road, Des Plaines, Ill., U.S.A.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Example —

When the line ruptures a high or reverse differential will be produced across the main line valve. This actuates the trip valve that operates the alarm switch and the pneumatic operator that closes the main line valve.

When the alarm switch is closed, the line bridging relay will connect the remote alarm unit to the telephone line. The remote carrier transmitter and receiver unit will be energized.

The transmitter sends a 7.9-kc. tone.

The 7.9-kc receivers in both master and slave stations receive this signal and sound an alarm at both stations.

The master station then interrogates the line by transmitting a train of pulses at 7.3 kc. The stepping switches in the master unit, the slave unit, and the remote unit then step-up together. When the stepping switch in the remote alarm unit reaches the point corresponding to its particular code, the 7.9-kc transmitter, which was silenced by the first pulse of the interrogation chain, will be re-energized to mark the value identification. The interrogation will continue through the remaining points and any other remote alarm units that are energized will also respond at their corresponding codes.

If, after a predetermined time from the initial alarm, the master station has not begun its interrogation, the slave station will interrogate the line. In this case, the master will become a slave if its circuitry is still sound enough. The remote alarm units that have been energized will remain connected to the telephone line for later re-interrogation until they have been reset manually.

In operation, the sounding of the alarm will warn the terminal control operator, who will reset the alarm and observe on the display panel which alarm function has been identified. He may then check his display by means of a valve check switch, which will cycle the stepping switch and repeat the identification. Had the alarm been triggered by noise, the alarm function indication will not reappear. In addition, a display check switch is available that cycles the holding relays and their associated identifying display lights to insure their correct operation.

Terminal alarm units at each end of the line under surveillance provides the equipment with a high degree of reliability, since a failure of one of the terminal units, or a break in the communication link to one of the terminal units, will not impair the identification of the alarm function. Sufficient signal strength is employed to overcome a partial grounding of the telephone line as might be experienced by a downed line. It is, in addition, safe from operator mismanagement, because the display indication can be cleared only by correcting the cause of the alarm function at its source and re-interrogating the line.

The transponder system is capable of extremely long life, because the remote alarm units are normally not energized. When they are energized by testing or actual value closure, the transmitter is active only during initial identification and the receiver and line bridging relay, which remain energized until reset, require a very small battery drain.

The line rupture alarm system incorporates many new and untried features. The complete system and all individual units were thoroughly tested in the laboratory before being delivered to PG&E. These tests included operation of the remote alarm units for long periods at elevated temperatures, frequency stability tests, and simulated system operation.

As might be expected, a few "bugs" developed after the system was in operation; however, the most troublesome problem occurred as a result of damage to the equipment in transit.

The line rupture alarm system has only been required to function on periodic test — it is hoped that this will be its only function. Should the occasion arise, however, it is anticipated that the alarm system will perform satisfactorily.

The Seats are the SECRET!

W-K-M's NEW *Pressure Sealing* GATE VALVE

ASA 150 lb. (275 cwp)
and ASA 300 lb. (720 cwp)

Approved for many services including:

air • gas • water • butane/propane gasoline • kerosene • alipathic alcohols aliphatic hydrocarbons • animal and vegetable oils • crude oils • naphtha • glycerol ethylene glycol.

Line Pressure Seals the Seats

The seats – made of specially formulated rubber molded to a hardened steel insert – are the secret to the valve's tight sealing performance. As line pressure in the valve increases, these unique seats actually float with the pressure to seal tightest where the most pressure is exerted.

Important Safety Feature

Excessive body pressure caused by thermal expansion is automatically relieved. The upstream seat is forced away from the gate by the excess pressure, allowing it to bleed into the line.

Change Seats in Minutes—on the line

You can change seats in W-K-M's Pressure Sealing Gate Valve (2" through 12") in 15 to 30 minutes . . . *on the line.* The only tools needed are a wrench and a pair of pliers.

Full Bore, Through-Conduit

Full bore, through-conduit gate construction permits a smooth flow with no more turbulence or pressure drop than through an equal length of pipe. The seats are fully protected from abrasive action of the lading flow.

Available Now

This versatile valve is available at leading supply stores everywhere. It's designed for pressures up to 720 psi (cwp) and temperatures up to 250° F.

ANOTHER OUTSTANDING PRODUCT OF W-K-M's *Creative Engineering*

Write for Catalog 1200

W-K-M Division of ACF Industries, Incorporated
P. O. Box 2117, Houston, Texas

W-K-M
SERVING INDUSTRY 40 YEARS

5909

Selecting TV Equipment To Fit The Problem

R. W. Hall *Diamond Power Speciality Corporation, Lancaster, Ohio*

IF YOUR COMPANY isn't using closed circuit or industrial television today, just be patient. Chances are TV will be there soon, because its cost is down and its efficiency keeps increasing.

The closed circuit of industrial TV systems in use today consist of four basic components: (1) **Camera,** (2) **monitor or receiver,** (3) **power supply,** and (4) **connecting link.**

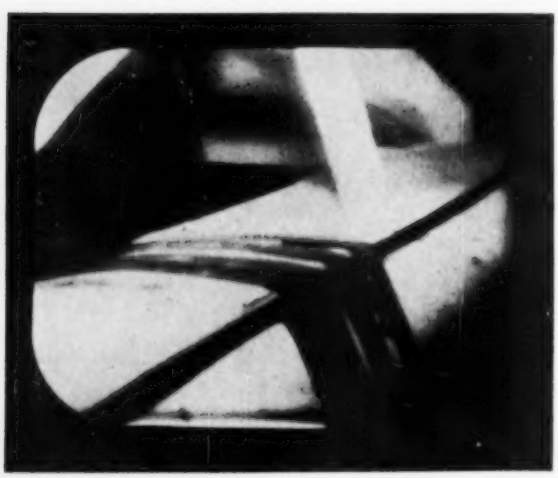
The camera. Self-contained cameras that include power supply are available, as are cameras with separate control units that house power supply. The most important aspect of selecting a camera is the camera tube.

Camera tubes. These are three types of camera tubes available for the industrial TV camera. They are the image dissector, or the cold cathode tube, and vidicon tube, and the orthicon tube. The last is a high fidelity tube normally found in commercial TV stations.

The image dissector tube has a number of advantages. It has a long life, rugged construction, shock resistance, and circuit simplicity. However, the quality of image is sacrificed for other characteristics and it takes 150 to 200 ft-candle illumination to produce a responsible picture. This tube is sensitive to the infrared spectrum and sometimes obtains a more informative picture of incandescent bodies than does the human eye.

It is proving useful for such applications as viewing furnace interiors, billet loading in steel smelters, or such applications where lighting values are quite high and picture resolution is not of prime importance. It is not subject to blooming where high light levels are encountered.

The vidicon type camera tube is of the filamentary type and is capable of providing a high resolution of 300 to 600 lines. A good definition can be obtained with incident illumination as low as 5 ft-candles; however, approximately 50 to 100 ft-candles are accepted as the mean requirements for a good picture.



Television screen shows pontoons on a pulling sled used in underwater pipeline construction.

The orthicon tube, normally used in commercial television studio cameras, has been used in closed circuit television where extremely good definition is required under very low light levels, such as underwater viewing, etc. Although the orthicon tube is eye sensitive, it is normally not considered for industrial TV because of its high initial cost and non-suitability for continuous use.

Standard TV receivers or video monitors can be utilized for industrial television viewing.

Connecting link. It is a consistent practice to use coaxial cable as the transmitter between the camera and receiver with booster stations if required. However, where long distances must be covered microwave lengths can be substituted.

In planning an industrial TV system, high quality design and equipment dependability should be of prime consideration, and should not be sacrificed in the interest of marginal features that do not contribute to the equipment's real function.

Applications and Installations

The best application in the gas industry appears to fall into the general category of transmitting pressure information from a remote point to a dispatching office. Microwave normally is assumed to be the most practical method of video signal transmission; however, if distances are not too great, video signals can be transmitted over telephone wires through a pulse system.

Possible Applications

1. *Internal inspection of pipelines.*
2. *Inspection and construction of underwater lines.* This application has been made on several occasions.
3. *A fire watch and guard against vandalism* at remotely operated stations.
4. *Instrumentation at remote stations.*
5. *Visual education.* There are job training films for industrial TV, and, of course, live telecasts may sometimes be useful.
6. *Inter-office communications.*

The degree of automation achieved on pipeline systems will determine to what extent industrial TV is used by this industry. Chances are, the use will be widespread in the not too distant future, and more and more functions will be delegated to the staff in the home office, rather than to field personnel.

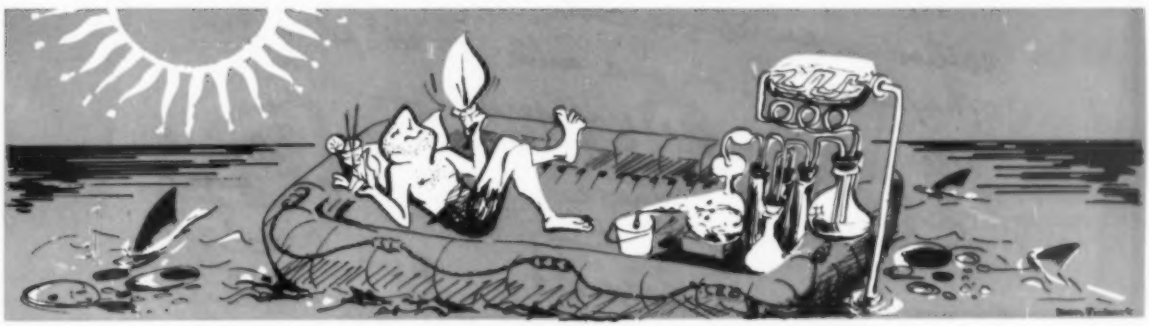
Acknowledgment. This Graphic Engineering Digest was prepared from a paper presented at the Transmission Conference of the Pacific Coast Gas Association at San Diego, California.

★ ★ ★

DEVELOPMENTS TO WATCH

from the field and laboratory

Science Gaining on Salt Water Conversion



SALT WATER PROBLEMS? Consider the plight of the gold-mining companies of the South African Orange Free State who must contend daily with disposal of 18 million gal of water too brackish for human use and destructive to farmlands. In this case, however, there's a twist, and a happy one. Turning away from the evaporation methods now used, scientists of the South African Council for Scientific and Industrial Research are building a huge "membrane-process" plant that will not only desalt and make palatable 3,000,000 gal daily but provide information leading to erection of similar plants to supply fresh water to towns, stock farmers, and others in an area now useless desert. And if costs can be reduced there is every possibility of treating saline waters for use in irrigation.

Yes, the oil industry has used the technique. As early as 1950 the Kuwait Oil Company, using six evaporators, began converting 720,000 gal of salt water daily to drinking water. So impressive were the results that similar machines were installed by the emirate, and now the entire 200,000-citizen population of Kuwait subsists on the 5,000,000 gal of sweet water drawn each day from the salty Persian Gulf. Similarly oilmen have introduced these same methods to the extremely dry islands of Netherlands West Indies, Curaçao, and Aruba.

These facts are among those brought out in an article by Blake Clark in the *Popular Science Magazine*, wherein is presented a graphic, up-to-date report on current progress in the ages-old dream of utilization of salt water. Pointing out that same half a million people over the world already live on de-salted water, Clark casts an encouraging light on the future. Yet he is cautious to add that present prices of treating the salt water are prohibitive for the economically feasible application of the process in this country.

There's no lack of agreement that new sources of fresh water must be developed. The author notes that a single paper mill in Texas uses 22,000,000 gal a day, that 300 gal are required for production of one barrel of beer, and that enough water to satisfy the 915,000 residents of Cleveland is used daily by a single oil refinery. All in all 250 billion gal a day are consumed in the U. S. — 47 percent by industry alone — just half of what the demand is expected to be 20 years from now. Yet, despite this prodigious rate of increase in usage, the fresh water supply in as many as 13 western states is adjudged from only fair to acute, with many communities gulping water faster than their reservoirs can be replenished. Sadly enough, huge deposits of millions of gallons of brackish water underlie many of these water-short regions.

Thus the headlong rush to make conversion economically practicable, for, to date, cost of de-salting is far in excess of the maximum that towns and farmers can afford. Cities, says the Office of Saline Water of the Department of the Interior, can afford to pay only 35 cents per thousand gallons and irrigated farms no more than 13 cents, figures hardly compatible with the $1.96 per thousand it costs the Pacific Gas and Electric Company of San Francisco to convert for its own use some 30,000 gal of sea water each day.

Three current methods of de-salting are discussed by Clark:

Distillation, the most advanced, entails simply the process of boiling the salt water and drawing off steam which, when cooled, is pure water. The method is used by all navies and by most passenger ships, and is the one referred to in the case of Kuwait and the West Indies Islands.

Operating at equivalent cost is what is called the membrane process, which exploits the electrical charges of sodium (positive) and chlorine (negative) ions inherent in salt water. Briefly, salt water is run between two electrically charged poles; sodium ions move through "one-way" membranes toward the negative pole and chloride ions toward the positive, leaving in alternate compartments fresh, demineralized water and a heavy saline solution in the proportion of about two parts pure to one part saline. Made up of great batteries of as many as 300 of these units, the plant can run continuously with little attention and almost no maintenance. One advantage of the membrane process: The lower the salt content of the water ingested, the cheaper the cost of operation, thus it seems especially suited to water that is brackish and less salty than sea water. In addition to the giant plant under construction in South Africa, some 20 of

From the desk of **J. L. MARTIN**

Don—

Have you seen these latest figures on cathodic protection costs on pipelines? They're based on one mile of 24" pipe after several years of service—

Coating	Resistance (ohms/sq. ft.)	Installation	Annual Upkeep
Coal Tar Enamel	300,000+	$112.	$33.
"Economy" Enamel	10,000-	$2,740.	$520.

I'm convinced we can hardly afford to use anything but coal tar for our new line. Let's specify Pitt Chem Modified Coal Tar Enamel. I understand they make top quality products—and back them up with excellent technical field service.

Jim

- ★ PITT CHEM® Coal Tar Pipeline Enamels
- ★ PITT CHEM "Tarmastic"® Coal Tar Coatings
- ★ PITT CHEM "Tarset"® Coal Tar-Epoxy Resin Coatings
- ★ PITT CHEM "Insul-Mastic"® Gilsonite-Asphalt Coatings

PROTECTIVE COATINGS DIVISION

PITTSBURGH COKE & CHEMICAL CO.

Grant Building • Pittsburgh 19, Pa.

WSW 7457

PROTECTIVE COATINGS • COAL CHEMICALS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON • FERROMANGANESE

these purifiers now supply the fresh water needs of about 30,000 people in places ranging from the island of Bahrein in the Persian Gulf to a remote radar base in Montana, from the offshore Texas towers to the southern Libyan desert where oilmen are at work.

Then, of course, there's the solar still, developed by Dr. Maria Telkes of New York University and undoubtedly responsible for the saving of the lives of many airmen forced down at sea. Operating on the principle that the sun draws salt water skyward, distilling it in the process, the solar still employs a glass pane canted over a tray of salt water; vapor of distilled water collects on the glass and runs into a gutter for collection. Though the amounts purified are small — ranging from a quart daily in the aviator's emergency kit to perhaps 9 gal with a 48-sq-ft tray—they are surely priceless to isolated peoples, such as those converting the brackish water in African oases or the sheep raisers of water-poor Australia.

Meanwhile, under stimulation and research sponsorship of the Office of Saline Water, new methods are being tried and old ones improved upon. With this amount of collective effort in evidence, all signs indicate that salt water converted to fresh may well have lost its aspects of novelty within a very few years. When one recalls that the entire course of human history has been affected by migrations of peoples from barren lands, and envisions wholesale displacements to wastelands made arable by water piped from the sea, one must admit that the possibilities are almost too staggering for easy comprehension.

Fastest Camera Shutter

TROUBLED WITH BLURRED ACTION SHOTS? Perhaps you'd do better with this ultra high-speed camera recently unveiled by Electro-Optical Systems, Inc., to be used in the study of explosions, shockwaves, and special nuclear reactions.

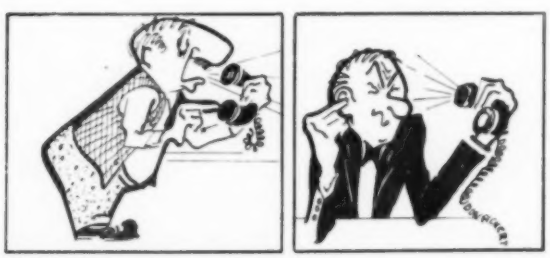
The camera has an effective exposure time of 5 billionths of 1 second. It could, for example, catch an 18,000 mph satellite in flight in the time required for that projectile to negotiate a distance shorter than the thickness of a human hair. Possessed of a hermetically sealed, large aperture, wide angle shutter without moving parts, it is pulsed electronically. Dr. A. M. Zarem, president of the company, says that improvements should enable the camera to take pictures having an exposure time of only a fraction of a billionth of a second.

Volcanic Steam to Power Electric Plant

NEW ZEALAND, world leader in per capita consumption of electricity, has long been faced with the problem of upping the power supply to satisfy increasing population demands. Blessed with little coal and no petroleum, the island has thus far relied on hydroelectric power, but this source alone will soon be inadequate for a population increasing at a rate of two percent per year. The result, according to *The Scientific American,* is a unique solution: Geothermal energy, or a power plant utilizing volcanic steam, the first of its size in the world.

Just as in Yellowstone National Park, geysers, steam jets, and pools of boiling mud result from the contact of the water table against subterranean rocks, the same phenomena are happening in the Lake Taupo area of North Island. A small test bore was found to produce 130,000 lb of water and steam per hour with a roar audible four miles distant. With the steam available near large cities, but also capable of being tapped anywhere over a 3000 sq mile area, the concept of its utilization came as a provident answer, and construction of the first power plant is now underway.

The plant, slated for completion in the middle of this year, is expected to produce 60,000 kw, using dry, superheated steam from high-pressure bores. This output might possibly rise to 250,000 kw if it were found that wet steams and hot water could also be used.



Your Nickel

A NEW GERMAN TELEPHONE handset features a knob on the receiver that controls a small amplifier, enabling the listener to adjust the volume at his end.

PART 2

Scheduling and Dispatching Crude Oil and Refined Products

Fred Ashford, Jr. *Division Manager, Oil Traffic Division*
The Texas Pipe Line Company, Houston, Texas

Line inventory record. I have previously mentioned that we handle several different grades of crude oil simultaneously in the pipelines. In order to maintain this segregation and keep track of the batches as they move through the line, a line inventory record is used. A sample copy is shown in Exhibit "E." On this sheet you will see a line diagram of the system, and the figure between the stations is the line displacement in barrels between the two stations. This record is based on information on the Daily Pumping Record and is computed in gross barrels as of 7:00 a.m. each day.

The method of computation begins with the Line Inventory Record for the preceding day. Using the information on the Daily Pumping Record, each batch is forced into the line at the originating station in the sequence in which it is pumped. Refer to Exhibit "E" and note that Station "A" was pumping sweet crude at 7:00 a.m. and had pumped 112,000 bbl of sweet crude. Immediately preceding this, Station "A" had pumped 80,000 bbl of sour crude.

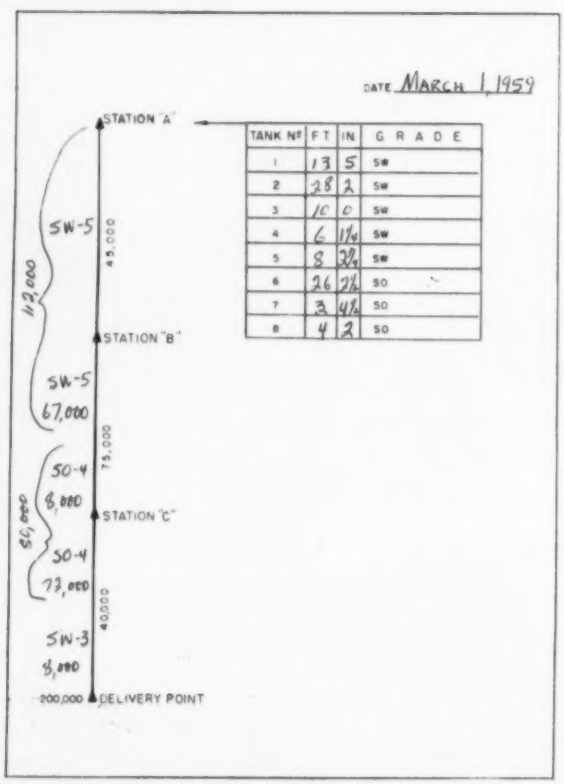


EXHIBIT "E"

Also shown on this sheet is the 7:00 a.m. tank gages for the tanks at each station. It is by use of these tank gages that the dispatcher is able to check stock and room for each grade. Of course, the dispatcher knows the oil height and normal low level of each tank in the system.

The line inventory sheet is also the basis for orders to the receiving stations. Let us look at the Line Inventory Record, Exhibit "E," and start at Delivery Point and go back toward Station "C." You see the batches as:

8,000 bbl SW

80,000 bbl SO

112,000 bbl SW

Now look at Order A-111, Exhibit "C," which is a receiving order to Delivery Point. He will deliver 8000 bbl of sweet crude to "X" Refining Company, followed by 40,000 bbl sour crude, then cut to "Y" Refining Company and deliver 40,000 bbl sour crude, followed by 56,000 bbl sweet crude.

Interfacial mixture on crude lines. As mentioned previously, batch changes on crude oil are made according to shippers' instructions. Exhibit "F" is a graph showing an actual batch change that occurs on 172.3 miles of 24-in. line. You will note that the gravity of the North Texas Crude at the time of first change is 40.3. The change is fairly uniform for the 21 minutes of the change to a gravity of 44.6 deg. The total amount of interfacial mixture is 1911 bbl. Exhibit "G" shows a batch change on 171.9 miles of 22-in. line. The amount of interface can be estimated prior to actual operation by means of a mathematical formula.

SCHEDULING AND DISPATCHING REFINED PRODUCTS

General. Scheduling and dispatching of refined products is similar to, but more complicated and exacting than, the handling of crude oil. The basic reason for this is that refined products are moved from a refinery through the pipeline into sales terminals, and each product has been blended to certain specifications.

If one product is allowed to become mixed with another product, then the quality of that product is affected and

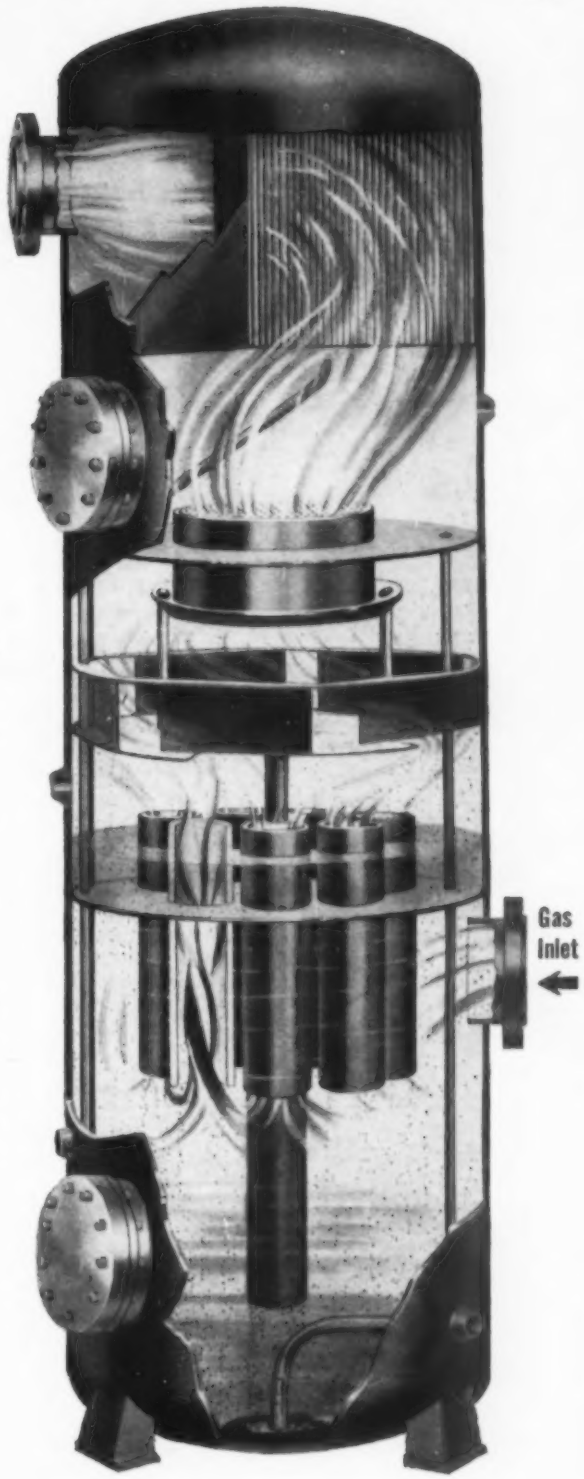
NEW BLAW-KNOX "M-P" (multi-phase) GAS CLEANERS handle high volumes . . . extreme load swings

"M-P" MEANS MORE PHASES OF GAS SCRUBBING AND OIL SEPARATION

4 PHASES OF GAS SCRUBBING give better contact between gas and scrubbing liquid

6 PHASES OF SEPARATION of oil from gas assure less entrainment than ever before

- reduces number of cleaners needed; cuts down on piping foundations and oil handling facilities.
- limits oil loss to .02 to .03 gallon per million standard cubic feet of gas.
- removes virtually 100% of particles greater than 3 microns, 80% of sub-micron particles.
- efficient separation is maintained throughout high and low flows.
- available in 18" to 72" diameter models; capacities to 18,000,000 standard cubic feet per hour at 1000 psig, and for any desired design pressure.
- see how this revolutionary new gas cleaner can provide complete dust-erosion protection to compressors, regulators, and metering equipment. Write for details.



BLAW-KNOX

BLAW-KNOX COMPANY
Buflovak Equipment Division
1547 Fillmore Avenue, Buffalo 11, New York

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

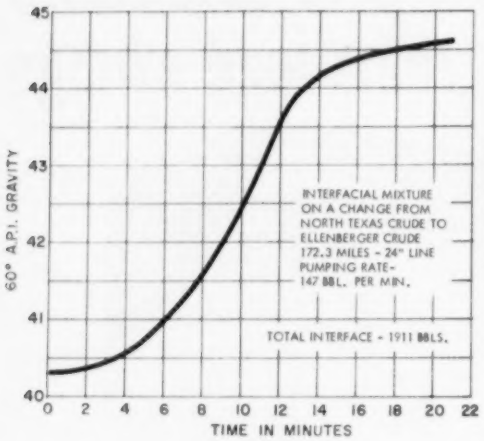

60° A.P.I. GRAVITY
TIME IN MINUTES
INTERFACIAL MIXTURE ON A CHANGE FROM NORTH TEXAS CRUDE TO ELLENBERGER CRUDE 172.3 MILES - 24" LINE PUMPING RATE - 147 BBL. PER MIN.
TOTAL INTERFACE - 1911 BBLS.

EXHIBIT "F"

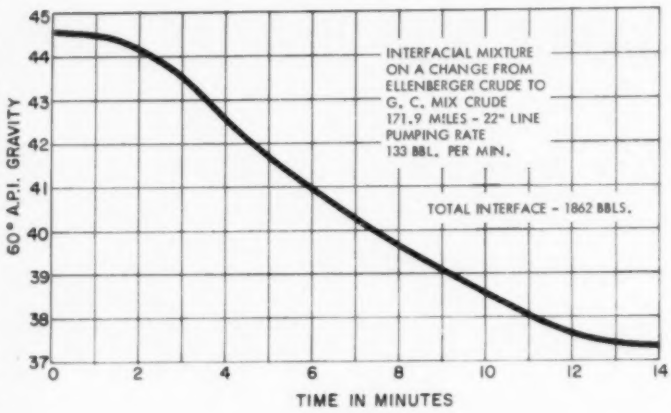

60° A.P.I. GRAVITY
TIME IN MINUTES
INTERFACIAL MIXTURE ON A CHANGE FROM ELLENBERGER CRUDE TO G. C. MIX CRUDE 171.9 MILES - 22" LINE PUMPING RATE 133 BBL. PER MIN.
TOTAL INTERFACE - 1862 BBLS.

EXHIBIT "G"

the product is "off-test." when this happens, it becomes necessary to transport this "off-test" product back to the refinery for re-run or blend it with other good product at a very low percentage blend. Either way, it is a very costly process and everyone concerned with products must be accurate and efficient in doing his assigned job.

An example of the above is an event that happened several years ago. About 600 bbl of gasoline was allowed to go into a tank containing 45,000 bbl of diesel fuel, and the tank of diesel fuel was immediately "off-test" as the flash point dropped to room temperature, whereas the specifications called for about 175 deg. This was caused by the man at the station being confused as to the predicted time of the batch change. In this case, it was possible to blend the "off-test" diesel with good diesel at a low percentage mixture. However, it took more than a year to accomplish this blending, and all this time a tank was tied up and could not be used normally. So you can see that batch changes must be made accurately, with full attention given to the handling of refined products in a pipeline.

The product cycle. The product cycle or sequence of batches is shown diagrammatically in Exhibit "H." In order to maintain quality of product and hold the monetary loss by downgrading to a minimum, it is necessary that a certain sequence of pumping batches into a pipeline be maintained. Exhibit "H" also shows, by means of arrows and the explanation below, the proper disposition of all interfaces.

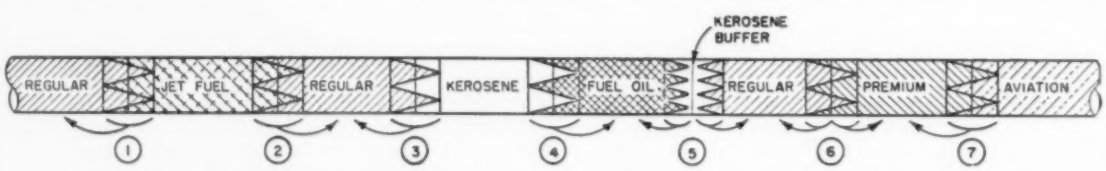
Batch numbers. In handling products in a pipeline, there is a definite advantage in having each batch assigned with a code that will identify that batch for the shipper, dispatching office, and field personnel. Exhibit "I" explains how batches are numbered.

Products line schedules. We have previously covered the "cycle system" of scheduling crude oil, and the same basic system is used for products. Actually this system originated on products systems and was adapted to crude oil. The main difference is that in products scheduling the cycle is based on the daily requirements at the sales terminals, giving consideration to tankage and fuel cycles.

Basically, there are two methods of scheduling products lines. The first method is the operation of a products line that delivers to a connecting system and that connecting system delivers to the sales terminals.

In this type of scheduling, the connecting system or deliverer to sales terminals develops his schedule, then the schedule for your system is made, taking into consideration the schedule of the other line and maintaining a minimum number of fuel cycles. This will enable you to schedule receipts into this system from the refineries or connecting carriers.

The second method of scheduling is the type of operation



1. Regular — jet fuel commingling must be cut to regular.
2. Jet fuel — regular commingling must be cut to regular.
3. Regular — kerosene commingling must be cut to regular.
4. Kerosene — fuel oil commingling must be cut directly to fuel oil.
   (A) Furnace oil – diesel fuel commingling can be split both ways with no loss or degradation.
5. Kerosene buffer between fuel oils and regular is cut both ways at kerosene gravity.
6. Regular — premium commingling can be split both ways with no loss or degradation.
7. Premium — aviation commingling can be cut directly to premium in order to protect aviation.

EXHIBIT "H"

NEW WmSON TAPRSEAL®

SCRAPER CUP

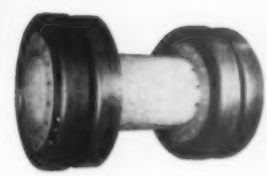
OFFERS PROVEN RESISTANCE TO WEAR, TEAR AND SWELLING!

TAPRSEAL DESIGN
Uniform taper of cup distributes stress, eliminating high stress points.

Actual photographs of TAPRSEAL cup before and after simulated pipeline test in ethyl gasoline for five days (500 miles)

Williamson testing equipment, the only repetitive COMPARATIVE cup tester in existence, has proven the TAPRSEAL to be WEAR RESISTANT . . . TEAR RESISTANT and SWELL RESISTANT. As the photographs show, there were no tears or breaks and only minimum wear after this torturous test.

Specify WmSon TAPRSEAL Scraper Cups . . . developed after years of research . . . proven after months of testing.



TAPRSEAL Scraper cups for all types of pipeline scrapers from 2" to 36".

PIONEERS OF PIPELINE EQUIPMENT

T.D. Williamson, Inc.
P. O. BOX 40 TULSA 2, OKLAHOMA

REPRESENTATIVES AROUND THE WORLD

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

wherein your company is the delivering carrier to sales terminals. Cycles are selected according to the terminal tankage and demand. You may have a 5-day cycle, 10-day cycle, or some other selected number that fits your system. A schedule for this system is then developed and your requirements given to the connecting carriers.

Of course, it is possible to operate one system which would receive products from the refineries, and all deliveries are made through one system to the sales terminals.

BATCH NUMBERS

GENERAL

A batch of a certain product is that volume which is pumped into the line in one continuous operation.

NUMBERING OF BATCHES

Basically, the batch number will be composed of: (1) the shipper designation, (2) the number designation of the product in the batch and (3) the number of batches of that product run for that shipper since the first of the year.

1. Shipper Designation:
   - Texas — T
   - Magnolia — M
   - Humble — H
   - Gulf — G
   - Sinclair — SN
   - Common Product — K
2. Product Designation:
   - 1 — Premium Gasoline
   - 2 — Housebrand Gasoline
   - 3 — White Gasoline
   - 4 — Kerosine
   - 5 — Jet Fuel
   - 6 — Furnace Oil
   - 7 — Diesel Fuel
   - 8 — 90 Octane Aviation
   - 9 — 100 Octane Aviation
   - 10 — 115 Octane Aviation
3. Examples:
   - T-2-12 — Twelfth batch of Texas Housebrand
   - G-7-10 — Tenth batch of Gulf Diesel Fuel
   - K-4-6 — Sixth batch of Kerosine (Common Product)

EXHIBIT "I"

PRODUCTS PIPE LINE COMPANY
PUMPING SCHEDULE

Pumping Rate — 1,000 B.P.H.

DATE	HEARNE	WACO	DALLAS
Start 8:00 AM 4-1-59	T-2-10 15,000 Finish 11:00 PM M-2-8 26,000	Open 8:00 AM T-2-10 25,000	
4-2-59	M-2-8	T-2-10 Finish 9:00 AM	Open 9:00 AM M-2-7 50,000
4-3-59	M-2-8 Finish 1:00 AM K-4-5 5,000 Finish 6:00 AM K-7-6 30,000		M-2-7
4-4-59	K-7-6 Finish 12:00 Noon K-4-6 5,000 Finish 5:00 PM T-2-11 48,000		M-2-7 Finish 11:00 AM T-2-10 18,000
4-5-59	T-2-11	Open 5:00 AM K-4-5 3,000 Finish 8:00 AM K-7-6 20,000	T-2-10 Finish 5:00 AM
4-6-59	T-2-11 Finish 5:00 PM T-1-7 30,000	K-7-6 Finish 4:00 AM	Open 4:00 AM T-2-10 22,000

EXHIBIT "J"

Form PL-35 (5-58) 100M

Pumping Order No. E-432 Houston, Texas, March 31, 1959

To Engineer At Hearne

Starting at 8:00 A.M., 4-1-59, Hearne will pump following batches:

T-2-10 for 15,000 bbls. from 1832.
M-2-8 for 26,000 bbls. from 1777.
K-4-5 for 5,000 bbls. from 1793.
K-7-6 for 30,000 bbls. from 1800.
K-4-6 for 5,000 bbls. from 1793.
T-2-11 for 48,000 bbls. from 1832.

I. M. CHIEF

IMC-WM
11:00 A.M.

EXHIBIT "K"

The same principles in scheduling would apply. Exhibit "J" is a typical products pipeline schedule.

Hearne is the originating station and deliveries are made to terminals at Waco and Dallas. The schedule includes a fuel movement, and you can see that the sequence of batches follows our previous discussion.

Pumping orders. Products pumping orders are similar to crude oil orders. An example is shown in Exhibit "K."

(To be continued in an early issue.)

Peru's Only Microwave System

The only microwave system in Peru is operated by the International Petroleum Company. Covering 22 miles, the two station, one-hop system provides communications between IPCO's oil production and refining activities in Talara and its production field offices in El Alto.

Talara station is located atop a bluff near that city. The microwave antenna is mounted on a marine light beacon tower.

The system was installed early in 1958 by V. M. LaPierre & Cia, S. A., the Motorola distributor in Peru.

The microwave system, which operates on frequencies in the 6000-mc region, provides 12 voice channels. These are used for telephone communications and terminate in IPCO's PBX switchboards in Talara and El Alto.

The microwave replaces a one-pair wireline between Talara and El Alto. The need for additional communications capability prompted installation of the expandable microwave. While 12 channels are now in use a total of 24 can be multiplexed with this type of equipment.

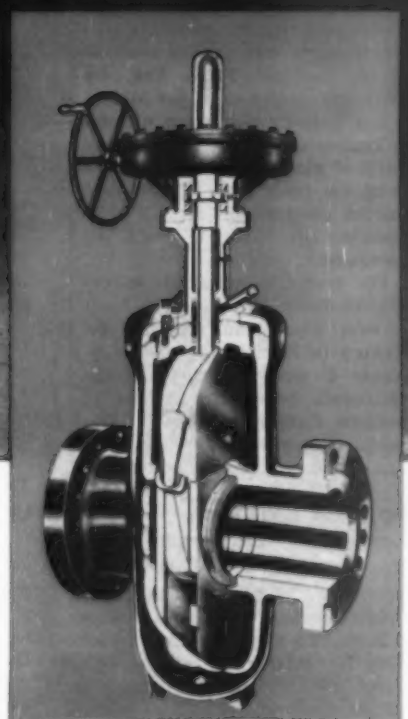
"Best Valve Insurance You Can Buy"

W-K-M® ASA Gate Valves

More than 300 rigid inspections certify the precision quality and long life that's built into every W-K-M pipeline valve. That's one reason W-K-M valves are recognized the world over for their superior construction and outstanding performance.

No other valves give you the same long-lasting service and economy. No other valves require so little maintenance.

Next time — and every time — specify W-K-M! Available at leading supply stores everywhere (from 2″ through 12″). Sizes through 34″ available on special order.



W-K-M Leverlock® Gate Valves feature through-conduit gate construction, parallel expanding gates, exclusive gate centralizers, controlled force seating, pressure seal bonnets, super-finished stems, seating surfaces sealed from the lading flow — and can be overhauled on-the-line.

Pressure Ratings: ASA 300 through ASA 1500 pounds.

Product of W-K-M's *Creative Engineering*

WRITE FOR CATALOG 300
W-K-M Division of
ACF Industries, Incorporated
P. O. Box 2117, Houston, Texas

W-K-M 40 SERVING INDUSTRY YEARS

5905

CONSTRUCTION

FEATURE

Pipeline Projects

FPC Authorizes Transwestern Line

Transwestern Pipeline Company has been authorized to build and operate a $191,000,000, 1809-mile pipeline to supply gas to southern California markets. The Federal Power Commission included in its order, however, the condition that Transwestern must reduce some of its gas purchase prices. The cuts range from 1 to 6 cents per Mcf.

It is hoped construction will not be further delayed, as $70,000,000 worth of pipe already has been laid along the route and Transwestern has let contracts to H. C. Price Company and Houston Contracting Company.

The system initially will deliver 300,000,000 cu ft daily from fields in west Texas and eastern New Mexico to Pacific Lighting Gas Supply Company at the Arizona-California border for resale in southern California. (See *Pipeline Engineer*, August, 1959.)

Two Ohio Fuel Plans Given OK, "Temporary"

The Ohio Fuel Gas Company has received a Federal Power Commission certificate to construct $1,740,500 pipeline facilities and a temporary authorization for another project estimated to cost $865,000, both intended to meet the continuing growth of market requirements.

The project which has been approved by the FPC includes 28 miles of 6 to 12-in. line in Hancock, Wyandot, Wayne, Stark, Carroll, Columbiana, Coshocton, Fairfield, Perry, and Muskingum Counties, Ohio; and 9 miles of 24-in. pipeline in Seneca County, Ohio, and the abandonment of existing facilities which will be replaced by sections of the new line.

Temporary authorization was earlier given to a proposal involving the construction of 6 miles of 24-in. pipeline in Licking County, Ohio, and the addition of 1500 hp to the Pavonia compressor station in Richland County, Ohio.

Big Midwest Projects Win FPC OK

Northern Natural Gas Company now has Federal Power Commission authority to begin natural gas service to 342 communities in six midwestern states.

In providing the service in Minnesota, Iowa, Wisconsin, South Dakota, Nebraska, and Illinois, Northern Natural plans to build pipeline facilities estimated to cost $114,618,000.

Iron Ranges Natural Gas Company simultaneously received authority to build a $7,614,000 pipeline system in Minnesota to serve 28 communities and several industrial customers. Iron Ranges will be supplied gas by Northern.

The commission's order imposed rate conditions on both Northern and Iron Ranges.

Other FPC actions related to the Northern Natural proposal included authorization to Permian Basin Pipeline Company to increase its sales of gas to Northern; to El Paso Natural Gas Company to increase deliveries to Northern with gas to be purchased from Phillips Petroleum Company; and to Phillips to abandon the sale of 50,000,000 cu ft daily which it now makes to Northern.

Trunkline's Expansion Underway In 3 States

Trunkline Gas Company, embarking upon an $81,458,000 expansion program that will increase the capacity of its natural gas transmission system to 510,000,000 cu ft daily (see *Pipeline Engineer*, July, 1959), is letting contracts for pipeline construction, some of which is already underway and almost completed.

Scheduled for early completion are 57 miles of 30-in. line between Union City and Henning, Tennessee, and 113 miles of the same diameter from New Denison to Tuscola, Illinois. The former is being constructed by C. S. LeNoir Construction Company, with W. B. Williams as general superintendent. Panama-Williams Corporation is laying the latter, and W. H. Shiflett is superintendent.

Construction is also reported in Cameron and Vermilion parishes, Louisiana, where Western Pipe Line, Inc., is laying approximately 44 miles of 4, 6, 16, and 20-in. line under the supervision of J. E. Buckner.

Grayco Constructors, Inc., report an expected starting date of September 15 for 53 miles of 30-in. between Pitkin and Pollock, Louisiana.

A contract to lay approximately 62 miles of 30-in. pipeline from Pollock to Mangum, Louisiana, has been awarded to APV Company, Inc. The contractor named A. Vaughn as superintendent and W. L. Hull as spreadman and Pollock, Louisiana, as temporary headquarters.

New Applications Call For 98 Miles of Line

The construction of a total of 98 miles of pipeline is involved in recent applications filed with the Federal Power Commission by Tennessee Gas Transmission Company, United Gas Pipe Line Company, and United Fuel Gas Company.

Tennessee's proposal includes approximately 76 miles of 30-in. loop line and additional 22,040 hp compression, at a cost of $14,990,000.

Approximately 8 miles of 16-in. lateral line and appurtenant facilities, at a cost of about $972,640, in Terrebonne Parish, Louisiana, are included in one application from United Gas to enable it to attach additional natural gas supplies in the Lapeyrouse area.

The company has filed a second application with the FPC seeking authority to construct approximately 9 miles of 30-in. natural gas pipeline paralleling a section of its system which will be submerged by a flood control project on the Angelina River in Texas. This line, estimated to cost $2,022,461, would parallel part of the existing line from the Agua Dulce field in Texas to Sterlington, Louisiana.

The company said it would be reimbursed for the cost of the construction by the government which is now building the McGee Bend Reservoir that will cover a portion of this line in Angelina and San Augustine counties, Texas.

United Fuel seeks authority to construct and operate about 5 miles of pipeline and 8400 hp in compressor capacity on its natural gas transmission system near Huntington, West Virginia, at a cost of approximately $3,568,300, as a part of the company's overall plan to replace portions of a low pressure transmission system between its Kenova compressor station on the west to the Lewis and Cobb stations on the east.

Great Lakes Reveals More Expansion Plans

Additional power for two sections of the Great Lakes Pipe Line Company system and a new satellite-type delivery terminal have been announced by the company as part of its $10,000,000 expansion program.

Previously announced were a 128-mile, 12-in. line from Iowa City to Middlebury Junction, Illinois, to complete a 12-in. line between Des Moines and Chicago, and a small delivery terminal at Marshall, Minnesota. (See *Pipeline Engineer*, August, 1959).

The company will install a 1100-hp dual-fuel diesel-powered pumping unit at the El Dorado, Kansas, station and add new unattended electric pumping units near Emporia and east of Lawrence to step up capacity of its 10-in. line from El Dorado to Kansas City. Neither of these electric units, 1500 and 1250 hp, respectively, will be housed, and both will be operated from El Dorado.

Great Lakes' 6-in. line from Fargo, North Dakota, will also get a capacity increase with the installation of a new diesel station near Hillsboro, North Dakota. The station, unattended and operated from Fargo, will provide a 42 percent increase in line capacity.

A terminal with two 30,000 bbl tanks and two-spot transport loading rack is planned for a location near Olathe, Kansas, several miles south of the Kansas City metropolitan area.

Construction of the previously announced line east of Iowa City is progressing rapidly, with completion expected in early September.

Continental Starts New Products Line

Start of a $2,500,000 pipeline and petroleum products terminal construction program by Continental Oil Company and its subsidiary, Continental Pipe Line Company, has been announced with the awarding of a contract to R. H. Fulton & Company for the construction of a 155-mile products line from Artesia, New Mexico, to El Paso, Texas.

The line, to be constructed and operated upon completion late this year by Continental Pipe Line Company, will connect at El Paso with the Southern Pacific products line to Tucson and Phoenix, Arizona, and with the Standard of Texas line to Albuquerque, New Mexico.

Included in the overall plan is Continental Oil Company's construction of petroleum products terminals at El Paso and Albuquerque. The El Paso terminal will be built east of the city and will have three storage tanks, with a total capacity of 77,500 bbl, an office building, and tank truck loading facilities. The Albuquerque terminal will be constructed south of the city and also will have three storage tanks, with a total capacity of 66,000 bbl, an office building, and tank truck loading facilities.

Completion of terminal construction work is expected by December.

Hope To Get Gas In Major Expansion OK

Approving applications that have been on the docket since February, the Federal Power Commission has authorized Texas Gas Transmission Corporation and Texas Eastern Transmission Corporation to expand their pipeline systems so they can transport up to 100,000,000 cu ft of natural gas daily for Hope Natural Gas Company.

Texas Gas' $40,000,000 expansion includes construction of about 246 miles of pipeline and other facilities to be built in Louisiana, Arkansas, Mississippi, Tennessee, Kentucky, Indiana, and Ohio. The gas, purchased or produced by Hope from fields in and offshore from Louisiana, will be delivered by Texas Gas to Texas Eastern at their existing interconnection near Lebanon, Ohio. (See *Pipeline Engineer*, February, 1959.)

PIPELINE PIONEER

The Original Vertical Pipe Bending Machine
Still Leads The Way . . . And Here's Why!

SPEED — Already the fastest bending machine, the CRC bender is now faster than ever with a new reversing clutch for equal speed forward and reverse in all four forward gears. You touch only one lever to raise and lower the pipe. A new torque converter gives a smoother power flow and more speed without shifting transmission.

SMOOTH, WRINKLE-FREE BENDS — Plenty of power on hand to pull smooth, non-wrinkling bends in the strongest pipe made. Flattening or egging of pipe walls held to absolute minimum.

NEW, NARROW WIDTH — CRC Model "B" bending machines are now under eight feet wide in the 20", 30", and 36" sizes for direct truck transporting to your job site. Tracks or rubber tires optional on all machines.

LOWEST MAINTENANCE — The mechanical, cable-operated vertical pipe bender stands alone as the most economical, trouble-free bending machine in use . . . no costly shut-downs due to parts failure, and no expensive mechanisms to replace.

Depend on CRC bending speed, accuracy, and ruggedness to get your job done *on time* day after day. Protect your investment with the pioneer of pipe benders, the CRC Vertical Pipe Bending Machine.

"SERVING PIPELINERS SINCE 1933"

CRC

CRUTCHER · ROLFS · CUMMINS, INC.

Home Office: Houston, Texas, Box 2073, UNderwood 4-6391

Branch Office: Farmington, N. M., Box 1207, DAvis 5-5523
Export Office: International Oil Equipment Co., 30 Rockefeller Plaza, New York, N. Y., COlumbus 5-6250
In Canada: Canadian Equipment Sales & Service Co., Ltd., 7310 99th St., Edmonton, Alberta, Canada

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Projects

Texas Illinois Plans More Gas for Midwest

Texas Illinois Natural Gas Pipeline Company, one of two long-distance transmission subsidiaries of The Peoples Gas Light and Coke Company, is seeking Federal Power Commission approval of a $43,500,000 construction program that involves an additional peak day delivery of 85,000,000 cu ft of natural gas to customer utility companies in a seven-state area in the midwest.

The major portion of the construction involved in the project would be the building of 371 miles of 30-in. line parallel to the company's 1400-mile line from the Texas Gulf Coast fields. The parallel line would consist of six sections. Also planned are about 55 miles of lateral lines and one new 6700-hp compressor station in Victoria County, Texas.

Gas supplies for the project, available under long-term contracts negotiated by Texas Illinois, would be obtained from producers in fields located from 6 to 21 miles from the existing pipeline. These are in Aransas, Brazoria, Calhoun, and Galveston counties, Texas.

Eskil I. Bjork, chairman of Peoples Gas, said it is currently expected that customer companies of the system pipelines other than those which serve the greater Chicago area will get most of the gas that will be available from this expansion project.

Texas Illinois has another application awaiting FPC approval proposing a 20,000,000 cu ft per day expansion to be delivered by increasing compressor facilities in existing stations.

Plans Mapped To Pipe B. C. Oil to Alberta

Peace River Oil Pipe Line Company is proposing an $8,500,000, 230-mile extension of its existing system to serve Beatton River, Milligan Creek, and Boundary Lake oil fields of British Columbia.

The proposed extension would supply the refineries at Dawson Creek, B. C., and Grande Prairie, Alberta, and deliver the surplus into the present system at the terminus in the North Sturgeon Lake field in Alberta. This line in turn extends southward through Alberta to connect with the Trans Mountain oil pipeline at Bickerdike, Alta.

Applications for the extension have been filed with the governments of B. C., Alberta, and with the Board of Transport Commissioners in Ottawa.

Peace River Oil Pipe Line is owned by nine oil companies. A British Columbia subsidiary of the Alberta company would be formed to construct the B. C. portion of the extension. An average of 10,442 bbl of oil daily were transported through the Peace River pipeline system during 1958.

Westcoast Transmission Company and Act Oils, Ltd., are two other groups considering plans to pipe B. C. oil to markets. The former already has done preliminary engineering on a proposed line through B. C. to Vancouver, and the latter has plans to market B. C. oil via a pipeline from Fort St. John to tidewater at Bella Coola, a distance of 470 miles.

International Notes . . .

Application to build a 25-mile, 4-in. spur pipeline in Saskatchewan to connect the Parkman Mississippian oil pool in the southeast corner of the province with the gathering system in the Arlington (Manor) pool has been filed by Producers Pipelines, Ltd.

Contract for construction in Indonesia of 156 miles of 20-in. crude oil pipeline and 7 miles of 16-in. submarine pipeline and related facilities has been awarded by one of the Royal Dutch Shell Group of companies to Williams Brothers Company.

the
SPREAD
is the thing . . .

. . . that makes the difference. The **spread** between a first class job and a mediocre one is simply this . . . the **spread** between close attention to details and a slip-shod operation.

Sheehan Spreads are famous for their close attention to details as well as friendly relations with property owners. From the first estimate to final clean-up, Sheehan's careful planning and efficient operation is aimed at making sure your job is a job well done.

Sheehan SPREADS . . . the mark of quality in pipeline construction

SHEEHAN PIPE LINE CONSTRUCTION CO TULSA OKLA

SHEEHAN

NATIONAL BANK OF TULSA BUILDING
TULSA, OKLAHOMA

WITH THE PIPELINE CONTRACTORS

● **APV Company, Inc., 1801 Continental National Bank Building, Fort Worth, Texas.** Has been awarded contract to construct 61.4 miles of 30-in. from Pollock, Louisiana, to valve 63 for *Trunkline Gas Company*. Field office is in Pollock. A Vaughn is superintendent, and W. L. Huff is spreadman.

● **Bechtel Corporation, 220 Bush Street, San Francisco 4, California.** Is double jointing 175 miles of 30-in. for *Midwestern Gas Transmission Company* at Kankakee, Illinois, under the supervision of A. U. Rigby.

● **Brown & Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has been awarded a contract to lay an undetermined amount of various size line in the Buras, Louisiana, area for *Shell Oil Company*, *The California Company*, and *Continental Oil Company*, with field office at Buras and John Landers as superintendent.

● **O. R. Burden Construction Corporation, P. O. Box 5216, Tulsa, Oklahoma.** Expect to start work September 1 on 120 miles of 8 in. through 14 in. for *South Texas Natural Gas Gathering Company* in south-central Texas. Also has been awarded a contract by *Humble Oil & Refining Company* to lay 15 miles of 10 and 12-in. pipeline in Nueces and Kleberg counties, Texas, with R. M. Jones as spreadman.

● **Cape Construction Company, Box 423, Cape Girardeau, Missouri.** Has been awarded a contract by *Consumers Power Company* to construct 22 miles of 24-in. and 119 miles of 26-in. natural gas pipeline between White Pigeon and a point northwest of Detroit, Michigan, with starting date to depend upon availability of pipe. There will be two spreads — one under Garland Mims, and the other supervised by Roy Whitworth.

● **Construction Service Company, Box 311, Bound Brook, New Jersey.** Has been awarded a contract by *Public Service Electric and Gas Company* to lay a 20-in. river crossing at Somerville, New Jersey, and expected completion date is September 15. Has received a contract from *Algonquin Gas Transmission Company* to construct 6 miles of 20-in. from Mendon to Bellingham, Massachusetts, with October 15 set as expected completion date. Is also working on 2 miles of 12-in. line between Bayonne and Jersey City, New Jersey, for the *New Jersey State Highway Department*.

● **R. H. Fulton & Company, P. O. Box 1526, Lubbock, Texas.** Has been awarded a contract by *Continental Pipe Line Company* to lay 155 miles of 6-in. pipeline from Artesia, New Mexico, to El Paso, Texas, with field office at Artesia under the supervision of H. L. Tinkler.

● **Grayco Constructors, Inc., P. O. Box 4147, Austin, Texas.** Is scheduled to start September 15 under contract with *Trunkline Gas Company* on a 53-mile, 30-in. line between Pitkin and Pollock, Louisiana.

● **Harbert Construction Corporation, Box 1369, Birmingham, Alabama.** Has been awarded a contract by *Southern Natural Gas Company* to construct 22 miles of 20-in. pipeline between Culloden and the Ocmulgee Station in Georgia and 22 miles of 14-in. from Griffin, Georgia, to the Ben Hill Station. Tommy Raschell is superintendent at the field office in Forsyth.

● **Houston Contracting Company, 2807 Buffalo Speedway, Houston 6, Texas.** Has contract to lay approximately 117 miles of 30-in. natural gas pipeline for *Texas Gas Transmission Corporation* in central and north Louisiana, with R. L. Silar as superintendent. Also has been awarded a contract to lay 35 miles of 8 and 14-in. pipeline and a dual 12-in. Mississippi River crossing for *Monterey Pipe Line Company* in the vicinity of Thibodaux, Louisiana, where the field office will be located under R. E. Thornton, superintendent. Also has been awarded a contract by *Houston Pipe Line Company* to lay 31 miles of 12-in. and 6 miles of 24-in. natural gas pipeline near Beaumont, Texas. R. L. Silar is superintendent, Odis Hare assistant superintendent, and D. L. Marley field office manager at Beaumont headquarters.

PIPELINE BLASTHOLER

Saves Time
Cuts Costs
Speeds Blasting

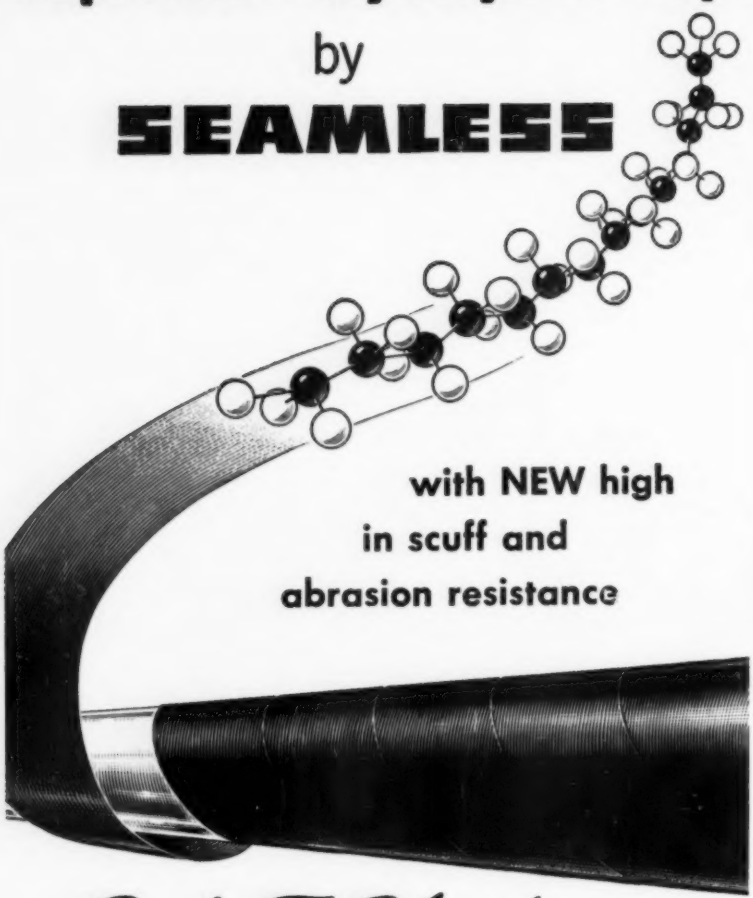
This self-propelled rotary drill unit does the work of 4 men, 2 sidebooms and 2 compressors on most pipeline blasthole operations. Mounted on tracks for terrain mobility, the BLASTHOLER drills blast holes 2 to 5 times faster than other cumbersome equipment, carries own air for cleaning hole. Standard unit drills holes from 2¼" to 3⅞" in diameter to 9' depth. Mast travels 40" laterally for staggering holes across ditch width, can be adjusted 14 degrees for angle drilling. Cut costs — speed blasting! See the BLASTHOLER today!

DRILLING ACCESSORY & MANUFACTURING CO., INC.
2006 S. Industrial Blvd. HA 8-8318 Dallas, Texas

Improved Polyethylene Tape

by

SEAMLESS



with NEW high
in scuff and
abrasion resistance

Safe-T-Clad #657

A modified polyethylene tape, SAFE-T-CLAD #657 is a successful blend of high and low molecular weight polyethylenes. Developed by SEAMLESS through technical knowledge of recent advances in chemistry, this new tape has high scuff and abrasion resistance properties never before attained with plastic films for pipe coating.

Designed specifically for machine application on all sizes of piping, SAFE-T-CLAD #657 has a higher density and tougher film formulation together with a higher adhesion level and better overlap seal.

For full specifications and particulars, contact your nearest distributor or write:

SAFE-T-CLAD DIVISION

THE SEAMLESS RUBBER COMPANY

464 CONGRESS AVENUE, NEW HAVEN 3, CONN.

A SUBSIDIARY OF THE REXALL DRUG & CHEMICAL COMPANY

Contractors

● **Joyce Pipeline Company, Box 385, Andover, New York.** Has been awarded a contract to lay 30 miles of 20-in. natural gas line in the Imperial Pennsylvania area for *Peoples Natural Gas Company.*

● **Majestic Quebec, Inc., 408 Royal Trust Building, Edmonton, Alberta, Canada.** Has been awarded a contract by *La Societe Gazifere de Hull* to construct a 16-in. crossing of the Ottawa River. Field office is in Hull, Quebec, and L. B. Finlayson is superintendent.

● **J. P. Neill & Company, Inc. 521 Meadows Building, Dallas 6, Texas.** Has been awarded a contract by *Transcontinental Gas Pipe Line Corporation* to construct 10 miles of 36-in. pipeline from Nutley to Clifton, New Jersey, under the supervision of Jack Hodges, with completion scheduled for September 30.

● **Oklahoma Contracting Company, P. O. Box 13227, Dallas 20, Texas.** Has been awarded a contract by *Southern Natural Gas Company* to construct 25 miles of 24-in. line from Gallion to Uniontown, Alabama, and 80 miles of 18-in. from Gwinville to Cranfield, Mississippi.

● **Panama, Inc., 2201 Commerce Building, Houston 2, Texas.** Has been awarded a contract by *Midwestern Gas Transmission Company* to construct 53 miles of line from the Ohio River to the White River near Algiers, Indiana. Also, has contracted to lay 118 miles of 30 in. from Kilbourne, Louisiana, to Ballentin, Mississippi, and 60 miles of 30 in. from Brownsville to Canadaville, Tennessee, and from Bardwell, Kentucky, to Polk, Tennessee, for *Trunkline Gas Company.*

● **H. H. Null Pipeline Contractors, 215 Lockwood Drive, Houston, Texas.** Will lay 48 miles of 16 in. and 31 miles of 4 to 12 in. from Hitchcock to Katy, Texas, for *Trunkline Gas Company.*

● **Paramount Constructors, Inc., Box 3266, Odessa Texas.** Has received a sub-contract from Vaughn & Taylor Construction Company to construct 21 miles of 30-in. line for *Cities Service Gas Company* between Welda and Princeton, Kansas, with field office at Garnett.

● **Pentzien, Inc., 1504 Dodge Street, Omaha, Nebraska.** Has been awarded a contract by *Great Lakes Pipe Line Company* to install a single 12-in. pipeline undercrossing the Mississippi River near Princeton, Iowa, where field office is located. James R. Zeman is spreadman.

● **H. C. Price Company, Price Tower, Bartlesville, Oklahoma.** Has been awarded a contract to construct 29 miles of 26-in. pipeline for *Tennessee Gas Pipeline Company* from Big Sandy River, near Ashland, Kentucky, to near Blue Sulphur Springs, West Virginia, with field office in Barboursville, West Virginia, under the supervision of C. R. Ice; and contracts from *Transcontinental Gas Pipe Line Corporation* to lay 39 miles of 36-in. from near Centerville to Clifton, New Jersey, under the supervision of Clarence Shivel, and 13,320 ft of 30-in. in Hunterdon County, New Jersey, with W. H. Olrich as superintendent.

● **Rosson-Richards Processing Company, P. O. Box 908, Corpus Christi, Texas.** Has been awarded a contract by *Tennessee Gas Transmission Company* to clean and paint 200 miles of 30-in. in Wisconsin, with headquarters at Oak Creek under Elton Hood, superintendent.

● **Sharman, Allen, Gay & Taylor, Inc., 3115 Buffalo Drive, Houston, Texas.** Has been awarded contract by *Midwestern Gas Transmission Company* to lay 43 miles of line from near Cromwell, Kentucky, to the Ohio River and to construct a crossing of the Green River in Kentucky. Also has received a contract from *Southern Natural Gas Company* to lay approximately 64 miles of 6, 12, 16, and 20-in. in Lafourche and Terrebonne Parishes, Louisiana, with E. D. Singleton as spreadman at the field office at La-Rose, Louisiana. Testing work began in July on 75 miles of 18-in. for *East Ohio Gas Company* in Columbiana, Mahoming, Belmont, Carroll, and Harrison counties. Headquarters are at New Philadelphia, Ohio. J. E. Allen is superintendent. Also, has been awarded contract to lay 41.9 miles of 24 in. from Moss Hill to Silsbee, Texas; 19.6 miles of 16 in. in the marsh and 5.3 miles of 14 in. in the Gulf to Block 26, Vermilion Parish, Louisiana, and 6.6 miles of 12 in. to Block 67, Cameron Parish, Louisiana, for *Trunkline Gas Company*.

● **Vaughn & Taylor Construction Company, Inc., Box 3266, Odessa, Texas.** Has received a contract to construct 22 miles of 30-in. natural gas pipeline between Ottawa and Welda, Kansas, for *Cities Service Gas Company*, under the supervision of H. A. Hane, with field office at Garnett, Kansas.

● **Western Pipe Line, Inc., P. O. Box 1076, Austin, Texas.** Has been awarded a contract by *Tennessee Gas Pipeline Company* to construct 72 miles of 30-in. between Portland and Winchester, Kentucky, with field office at Stanford under L. F. Visentine, superintendent. Also has received a contract from *Trunkline Gas Company* to lay 43 miles of 4, 6, 16, and 20-in. in Cameron and Vermilion Parishes, Louisiana. J. E. Buckner is superintendent and field office is in Gueydan.

PIPELINE PERSONALS

Joe T. Dickerson, president of Shell Pipe Line Corporation, announces that effective October 1 **R. H. Hord** will become manager of personnel and industrial relations, the position he now holds at Shell Oil Company's Wood River, Illinois, refinery. Hord succeeds **R. A. Pratt,** who will become administrative superintendent of Shell's Norco, Louisiana, refinery. Pratt succeeds **V. G. Harrison** who has been named administrative superintendent of the Wood River refinery. **A. J. Martin,** now a representative in Shell's head office industrial relations department, will succeed Hord at Wood River.

R. H. Hord

J. W. "Mac" McFarland, superintendent of Service Pipe Line Company's Joliet district, has retired after nearly 36 years with the company. McFarland assumed duties as a station engineer in Wyoming in July, 1923, and in following years saw service as a connection foreman, district foreman, and acting division superintendent in Illinois. He has been a district superintendent since July, 1945. McFarland will be succeeded by District Superintendent **J. J. Ashley,** Pauls Valley, Oklahoma.

Frank Dorr, Jr., project engineer, has joined Columbia Gulf Transmission Company; as well as **Howard S. Wright,** engineer. Dorr came to Columbia Gulf from Ebasco Services and formerly had his own corrosion engineering firm. Wright, for the past year, has been a pipeline district engineer for Gulf Oil Corporation.

James R. Whatley has been elected vice president, finance, of Pipe Line Technologists, Inc., and **Theodore Gupton** has been elected vice president, engineering. **Michael G. Shoup** was appointed controller.

Donald A. Robertson, controller and assistant secretary of Panhandle Eastern Pipe Line Company, has been elected a vice president of the Controllers Institute of America, a non-profit management organization of controllers and finance officers from all lines of business. Robertson has been active in the institute since 1948, is a national director and past president of its Kansas City, Missouri, Control, and served as general chairman when the Midwestern-Southern conference of the organization was held in that city in 1957.

Jim R. Rutherford, district engineer for the Jackson district of United Gas Pipe Line Company and Union Producing Company, has retired following over 30 years of service in engineering work for the companies. **George Evanoff** of the Shreveport district pipeline department, United Gas Corporation, has retired after a 33-year welding career with the company.

Write for Bulletin

PATENTED

NAME OR EMBLEM

PIPE CAS LINE

PIPELINE VENTS AND MARKERS

FLEET-LINE CO.

P. O. BOX 276-A
SHREVEPORT
LOUISIANA

Write for Specifications Folder

FLEET-LINE

WELDING FITTINGS

REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.

SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Complete encirclement saddles.

Fast interested service.
Write for Literature.

STEEL FORGINGS, Inc.

P. O. Box 276A • Shreveport, La.

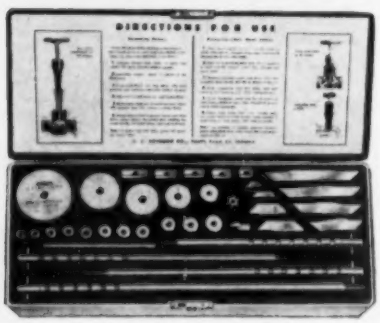
MOLE
Pipeline
Cleaner

for BETTER cleaning of
CRUDE LINES
PRODUCT LINES
NATURAL GAS LINES

FOR DETAILS WRITE

Pipeline Cleaners Co.
Fort Madison, Iowa

RESEATS VALVES and BIBBS QUICKLY ECONOMICALLY



Easily pays for itself on the first two jobs!

Reseats flat and tapered-seat globe or angle valves—all bibbs and faucets—in place, quickly and accurately. The saving, over tearing out and renewing leaky valves and fixtures, is tremendous.

Cutters operating under screw feed, leave worn, scored seats glass-smooth, level, absolutely accurate and tight.

A guide pilot centers each cutter; a tapered cone centers each spindle. Perfect alignment is inevitable. Cutters guaranteed. Write for literature!

2" for ¼" to 2" valves and ¼" to ¾" bibbs
List price $59.85

3" for ¼" to 3" valves and ¼" to ¾" bibbs
List price $79.50

FREE **catalog showing our pipe repair clamps, saddles, and reseating tools**

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

It's New | Pipeline Equipment

For Fastening to Steel, Concrete Underwater

An improved tool that can set fasteners instantaneously into ⅝-in. thick steel plate and high strength concrete underwater at depths up to 300 ft has been introduced. With application in fixing underwater pipelines and cables, the device is a capsule-like barrel which is factory-loaded with a fastener and powder-load and hermetically sealed at both ends. After tool is fired, the entire barrel is discarded and replaced underwater. Tool can be cocked easily so that a bouyant diver does not push himself away from the work. The diver, working in complete darkness, can also detect whether or not it is loaded while working beneath the surface. Its performance is not affected by water pressure, it can be reloaded underwater, it will not fire if held at an angle to the work surface, eliminating the danger of ricochet, and will not fire unless flush against the surface, insuring against accidental discharge. *Ramset, Fastening System, Olin Mathieson Chemical Corp.*

Circle number (81) on reply card.

Automatic Pipe Cutter

A new automatic pipe cutting and contouring machine that eliminates layouts, templates, and cams to shape pipe ends for any type of welding has been announced. Machine settings are made in less than 15 sec for any type contour cut, and one man easily controls the entire operation. Welding tees are unnecessary, and as many as 2 complete circumferential welds can be eliminated in the operation of tapping into a line with another pipe. Machine is equipped with 2 independently or simultaneous operating torches that can be laterally spaced as far as 3 ft apart. Adjustable tip holders can be positioned straight or on a bevel. Model 210 handles pipe from 1½ to 10 in.; Model 216 from 4 to 16 in.; and Model 424 from 6 to 24 in. Machine features electronic tip lighting and is available in stationary or portable models. *Steffan Manufacturing Corporation.*

Circle number (82) on reply card.

Dolly Trailer For Diesel Engines

A dolly trailer for handling diesel engines of various sizes, integrated with an automatic towveyor, has been announced. Trailer is of heavy-duty all-steel welded construction. Six uprights for engine loads, with flanges tapering out to the base supports, give strength for the heavy weights the trailer must bear. Three uprights on one side can be adjusted to various widths. A lever at the side operates a pin which drops into an electric conveyor chain circuit. By means of an automatic control mounted at the front, the trailer is guided into predesignated stations. Movement ceases when the pin is automatically raised by trailer bumper contact. Units have 4 rubber-tired wheels, 2 stationary and 2 swivel. Outer frame is of heavy-duty channel steel. *Palmer-Shile Company.*

Circle number (83) on reply card.

All-Purpose Body For 1-Ton Trucks

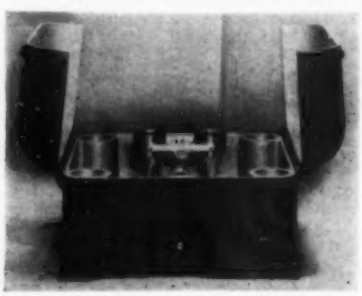
A new all-purpose body for 1-ton trucks has been designed specifically for use on jobs too heavy to handle by hand and too light to handle economically with larger size trucks. A smaller version of the Leland "packaged unit," the new

"Junior Packaged Unit" features: A rolling tail pipe of 4½-in. OD schedule 80 seamless pipe mounted on shielded ball bearings; gin poles of 2⅞-in. OD heavy wall seamless pipe; headache rack of 1½-in. and 2-in. pipe; an "A" frame for the top of the gin poles; 2-in. center matched hardwood floor with deck plate covering rear portion and with a bolster pin hole; and a toggle bar at the tail roller for gin pole work. Winch mounting brackets, body mounting brackets, clearance lights, reflectors, and a tool box are standard equipment. The body is equipped with channel runners and cross sills. Body length from front to tail roller is 8 ft; length behind the winch is 6 ft 4 in. Width of the body is 90 in., and complete weight is 1620 lb. *Leland Equipment Company.*

Circle number (84) on reply card.

New Aluminum Model Heated Centrifuge

A new heated centrifuge, the 100 ml Mark II, includes pear shaped tubes in its mechanism. A square shape structure has 4 preheater pockets where former



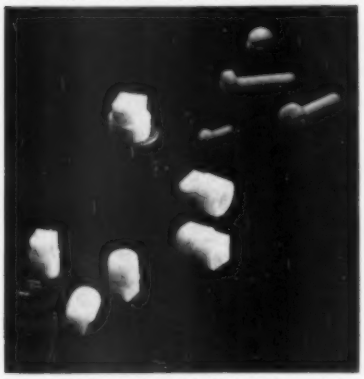
machines had only 2 pockets. Facilities to preheat samples and keep them hot during the spinning period assure higher degree of consistency and accuracy in bs&w measurements. The aluminum model circulates hot water from the operator's vehicle motor into a large water reservoir in the bottom of the centrifuge and has Rheostat control. *W. L. Walker Company.*

Circle number (85) on reply card.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Pipe Plug of "Delrin"

Commercial production is scheduled in mid-1959 of "Delrin" acetal resin — a tough, rigid thermoplastic with strength properties approaching those of the non-ferrous metals. The strength and resilience of "Delrin" acetal resin combine with its corrosion-resistance and easy fabrication to make pipe plugs of many head and thread designs. Seals against



pressures as nigh as 10,000 psi have been achieved in field tests, the manufacturer states, with pressures of 500 psi held consistently after repeated cycling from room temperature to 250 F. The resiliency of "Delrin" gives high thread engagement even with unevenly tapped holes, burrs, and the like. *E. I. du Pont de Nemours & Company.*

Circle number (87) on reply card.

Ten-Ft "Utility" Digger

A new digger for trenching, backfilling, loading and utility duties is announced. The Model 210's backhoe cuts 10 ft deep, reaches over 15 ft, side casts or loads into trucks up to 10 ft high, digs 14 ft of 4-ft deep trench or 6-½ lineal ft at 9-ft depth without changing position, and vertical trenches on side slopes up to 10 deg. The 1000-lb capacity loader does multiple duty with five interchangeable attachments. *J. I. Case Company.*

Circle number (88) on reply card.

Transistorized Tone Signalling Units

Completely transistorized units for all tone signalling requirements in remote supervisory capacities are now available. Modular design permits flexibility and freedom in expansion or modifications of the system after installation. Non-technical personnel can maintain the system through modular replacements. The module frame supplies the mechanical mounting to relay rack, plus the mounting areas for electrical power supply and five self-contained transmitter or receiver units. All units are designed to be serviced by the Hammarlund Test Meter which permits complete field adjustment and servicing by non-technical personnel. Switchover to emergency battery power supply is automatic upon power line failure. *Hammarlund Manufacturing Company, Inc.*

Circle number (89) on reply card.

It's New | Pipeline Literature

Spheres to Reduce Tank Oil Evaporation

A new 7-page bulletin describes tiny, hollow, plastic spheres filled with inert gas which reduce evaporation in crude oil tanks by floating on top as a continuous thick layer of foam and acting as a blanket. Properly installed, the manufacturer states, they will decrease evaporation by 80 to 90 percent. *Colton Chemical Company.*

Circle number (90) on reply card.

New Pump Design

Worthington Corporation has announced in a recent bulletin its new Ultra High Flow (UHF) vertical turbine pump. There are 36 different hydraulic designs in the standard UHF line (covering capacities of 40 to 4500 gal per min). The new UHF line is said to have peak efficiencies 4 percent greater than the previous line, and to maintain higher efficiencies over wider operating ranges. *Worthington Corporation.*

Circle number (91) on reply card.

Cathodic Protection

A condensed catalog of cathodic protection services and materials has been issued. Rectifiers, anodes and backfill, and cable and accessories are briefly described. *Corrosion Services Incorporated.*

Circle number (92) on reply card.

Tables, Formulas

Convenient tables, formulas, and graphical symbols summarizing electrical data, properties of materials, heat transfer and steam information, measurements, and other subjects are contained in a new 120-page booklet entitled "Convenient Tables and Formulas". *Westinghouse Electric Corporation.*

Circle number (93) on reply card.

Engine Log Book

Owners of diesel engines will be interested in a new book which covers 13 months of operation and contains space for daily entries on fuel and lube oil consumption, parts, service, repairs, etc. Monthly entries may be transferred to a 12-month summary sheet, and a post card is enclosed with which the operator can order a new book when the old one is used. *Engine Division, Caterpillar Tractor Company.*

Circle number (94) on reply card.

Pipe Wrap Tape Data

A 6-page pipe wrap tape brochure has been issued which includes vinyl pipe wrap tapes, polyethylene pipe wrap tape, and pipe wrap primer. A comprehensive chart of pipe wrap coverage data and specifications for use of the tapes is also included. *Permacel.*

Circle number (95) on reply card.

This report helps you save on pump-station maintenance

Here's a new Oakite Service Report – free, of course – on maintenance cleaning at the pipeline pumping station.

It's full of valuable, time-saving ideas ... any one of which might turn out to give you a deep cut in maintenance costs. You'll find helpful shortcuts on:

- Engine room maintenance
- Lube oil cooler maintenance
- Cleaning electric motors, generators, control panels, etc.
- Paint stripping
- Storage tank cleaning
- Cleaning crude and natural gas lines

FREE. Write for a free copy of this Oakite Service Report No. B6878. Address Oakite Products, Inc., 51A Rector Street, New York 6, N.Y.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
SCIENCE

In our 50th year

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

DESTINATION TOMORROW!
TODAY THE E/4 SHOULDER HOLIDAY DETECTOR AND THE E/P PULSE TYPE DETECTOR FOR DAMP CLIMATES ARE ANSWERING THE PIPELINERS NEED FOR A DEPENDABLE, FULLY PORTABLE, GENERAL PURPOSE ELECTRICAL INSPECTION INSTRUMENT.
BOTH MODELS CAN BE USED FOR A FULL DAY WITHOUT RECHARGING THE BATTERY. ALL WRAPPED SURFACES INCLUDING PIPE CAN BE QUICKLY AND ACCURATELY INSPECTED FOR VOIDS, PINHOLES, BREAKS, SCRATCHES AND BURNED OR COKED SPOTS
TOMORROW THESE SAME DETECTORS WILL BE USED IN THE INSPECTION OF TUBING ON OUTER SPACE ROCKETS. FOR TINKER & RASOR DETECTORS ARE DESIGNED FOR THE FUTURE.
DISTRIBUTORS
Crutsher-Reilfs-Cummings Inc. Houston, Texas
Reece Manufacturing Co., Inc. Tulsa, Oklahoma
Canadian Equipment Sales & Service Ltd. Edmonton, Alberta, Canada
Bob Herrick Rentals & Service Harrisburg, Penna.
Falcon Line Products Corp. Elizabeth, N.J.
Export Agents . . . Frazer & Hanson Ltd. San Francisco, Calif.
Electronic Detectors for every Industry
TINKER & RASOR
617 AGOSTINO ROAD, P. O. BOX 281, SAN GABRIEL CALIFORNIA

New Literature

Telepulse Described

High Speed Telepulse for telemetering is discussed in a new bulletin, in which the manufacturer points out such features as positive data or control point identification, positive error detection, data gathering, alarm condition reporting, dial or digital readout, and datalogging. The 60-ma current used in the S&J High Speed Telepulse loop is the same line current normally used by telephone companies, permitting use of leased transmission line. It may be used as a direct or remote selection system. Operations are detailed. *Shand and Jurs Company.*

Circle number (96) on reply card.

For Flow Control

Application of Gyrol fluid drives to pipeline pumping stations for pipeline flow control is described in a new 8-page, 2-color bulletin. Operating principles are explained and illustrated with an easy-to-understand schematic section drawing of a typical adjustable speed fluid drive. Both line characteristic and pump characteristic brake horsepower and pressure curves are shown for a broad range of pipeline flow requirements up to maximum. Three types of oil coolers for use with Gyrol fluid drives are described and illustrated also. *American-Standard Industrial Division.*

Circle number (97) on reply card.

Engine Line Data

A bulletin has been issued describing the International Harvester line of 24 engine models, ranging from stripped engines to complete power units with horsepower ratings from 16.5 to 385 to fit any requirement. In the carbureted models there are 14—4, 6 and 8-cylindered units fueled with LPG, natural gas, or gasoline, with maximum horsepower ranging from 16.5 to 248. The 10 diesel engines described are in both 4 and 6-cylinder versions with intermittent horsepower ranging from 70 to 385. *International Harvester Company.*

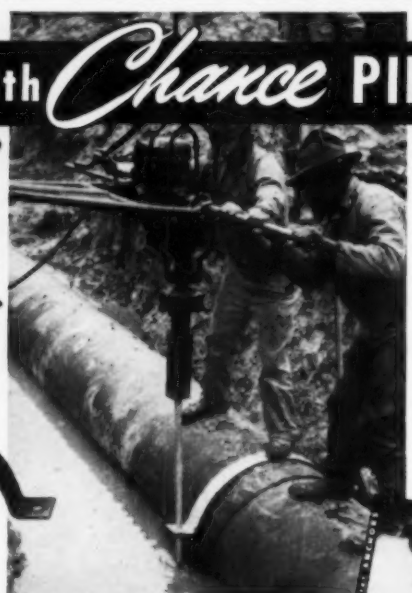
Circle number (98) on reply card.

Cut Costs with Chance PIPELINE Anchors

Save on • LABOR • TRANSPORTATION • STORAGE

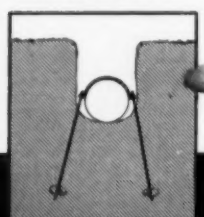
The modern, efficient method of anchoring pipeline is with Chance Pipeline Anchors and Brackets. It is the lowest cost, easiest, surest way to keep pipe from floating.

A complete unit (2 anchors and saddle bracket) weighs from 29 to 180 pounds and will securely hold from 5,000 to 30,000 pounds. It can be installed from the surface with hand tools or light power equipment, without additional excavation. Sizes available for almost any job.

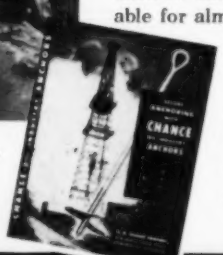


Crew installing Chance Anchor for United Gas Pipeline Company in Louisiana.

Cut-away view of anchor and bracket installed in trench.



Write for complete catalog and application information.



Advance test service to help you determine anchor requirements available without obligation.

A·B·CHANCE CO· CENTRALIA, MISSOURI
A. B. CHANCE COMPANY of CANADA LTD., TORONTO

Now you can positively locate the cement column and cement top . . . even in old wells. Lane-Wells' Cemoton Log is an exclusive method for obtaining accurate indications of cement tops, and, since it is not dependent upon thermal changes, it can be applied to wells of any age. The log is usually made in conjunction with other surveys using cased-hole equipment so that no extra rig time is required. It provides a valuable confirmation of casing collar locations and also indicates uncemented sections below the cement top. Easier to interpret, more accurate than a temperature log, and very economical when run with neutron or gamma ray-neutron surveys. It will pay you to check with your Lane-Wells man and get the Cemoton story firsthand. Ask to see sample logs or write direct for additional information.

LANE-WELLS COMPANY

A DIVISION OF DRESSER INDUSTRIES, INC.

P. O. BOX 1407, HOUSTON 1, TEXAS

In management...in research...in the field
...the key to quality is PEOPLE

HALLIBURTON *oil well cementing company* duncan, oklahoma